CITY OF GARY
DEPT. OF PUBLIC WORKS

GARY SANITARY
DISTRICT

GARY STORM WATER
MANAGEMENT DISTRICT

# Section 2

# Storm Water Design Standards

CITY OF GARY / GARY SANITARY DISTRICT / GARY STORM WATER MANAGEMENT DISTRICT
Gary, Indiana

***Section 2***
***Storm Water Design Standards***

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# CHAPTER 1

# INTRODUCTION

## 1-1 PURPOSE

The purpose of this section of the Manual is to establish minimum criteria for design and workmanship of storm sewers and storm water management systems. The jurisdiction of this volume is for the entire storm water system and appurtenances within City, GSWMD, and GSD right-of-ways and easements to the final point of discharge. The focus of this section is on storm water conveyance and post-construction storm water management. Storm water runoff control before and during construction is discussed in Chapter 7 of Section 1.

This section is also intended to present the technical and engineering procedures and criteria needed to comply with the City of Gary Storm Water Management Ordinance. A copy of this ordinance is provided in Appendix B of Section 1.

Addenda and / or revisions to this Manual may be issued periodically and will be distributed and made available to the public and contractors at the City of Gary Department of Public Works, GSD, and GSWMD. Users shall be responsible to keep apprised of any changes and revisions to this Manual.

## 1-2 APPLICABLE STANDARDS, REGULATIONS, AND ORDINANCES

The GSWMD is responsible for ensuring the proper installation of all facilities as part of storm sewers constructed in or connected to existing facilities and all storm water management systems. All facilities shall be designed and constructed in accordance with the requirements of this Manual as well as applicable State and Federal regulations. This includes, but is not limited to, the submission and approval of preliminary and final subdivision plats, permits for storm facilities construction, building and zoning permits, construction inspections, appeals, and similar matters.

It shall be the Owner's / Engineer's / Contractor's responsibility to comply with all requirements of the City or other authority having jurisdiction on work if such authority imposes greater requirements. Furthermore, the Owner / Engineer / Contractor shall be responsible for procuring all necessary permits and licenses, paying all charges and fees for acquiring and recording all easements, and giving all notices necessary and incidental to the work.

Any conflicts between this Manual and any applicable Federal or State laws shall be superseded by such law. If any conflict arises between this Manual and applicable City or County Ordinances, this Manual shall prevail. This Manual was approved and adopted by the Board of Public Works, City of Gary, Indiana; the Board of Commissioners, Gary Sanitary District, Gary, Indiana; and the Board of Directors, Gary Storm Water Management District, Gary, Indiana.

# CHAPTER 2
# PERMITTING

## 2-1 APPLICABILITY

A storm water management permit is required for all business, commercial, and industrial developments, residential subdivisions, planned unit developments, and any redevelopment or other new construction of like kind located within the City of Gary as stated in the Storm Water Ordinance. The Ordinance regulates:

1. storm water drainage improvements related to development of lands located within the City,
2. drainage control systems installed during new construction and grading of lots and other parcels of land,
3. erosion and sediment control systems installed during new construction and grading of lots and other parcels of land, and
4. the design, construction, and maintenance of storm water drainage facilities and systems.

The Ordinance also requires that the release rate of storm water from a site after development / redevelopment not exceed the 10 year return period storm water runoff from the site in its pre-development (present) state.

## 2-2 CONTROLLING AUTHORITY

The GSWMD issues final approval for the installation of all storm water management systems. All required permits (including a GSWMD storm water management permit) or exemption from other federal, state, and local units must be obtained prior to the commencement of construction of any storm water management system covered by this rule. All easements for collection system rights-of-way must prohibit the construction of any permanent structure over the storm sewer and must also provide enough access for maintenance with mechanical equipment.

## 2-3 PROCESS

The storm water management permit process begins when an applicant requests, in writing, a permit application from the GSWMD, 3600 West 3rd Avenue, Gary, Indiana, 46404. Upon receipt of the request, the GSWMD will provide a storm water management permit application to the applicant that contains a checklist that can be utilized to assess the completeness of the application packet. The applicant then sends the completed permit application, fee, and associated attachments, including plans and specifications, to the following for review:

Director
Gary Storm Water Management District
3600 West 3rd Avenue
Gary, Indiana 46404

Upon receipt, the application will be reviewed by the GSWMD, and / or a GSWMD representative, to ensure compliance with this Manual, City of Gary Ordinance No. 7309, and any rules promulgated by the GSWMD Board of Directors or the GSD Board of Commissioners. Written review comments on the submittal will be provided to the applicant. These comments shall be addressed by the applicant (design engineer or developer) and the permit application and associated attachments shall be appropriately updated and resubmitted.

Upon approval of the permit application, an approval letter and storm water management permit will be issued by the GSWMD. Once the permit has been approved by the GSWMD Board of Directors and signed by the applicant and a representative of the GSWMD, construction on the project may commence (assuming all other necessary permits have been obtained).

Upon final approval by the GSWMD, the applicant must provide a final copy of the finalized permit application, including drainage plan report and plans and specifications, to GSWMD in hard copy and digital formats.

## 2-4 APPLICATION

A copy of the storm water management permit application, including specific requirements and instructions for completing and submitting the permit application, are provided in Appendix H of Section 1. Required attachments to the application include:

1. Storm Water / Sanitary Sewer Fee Submittal Form

2. Storm Water Management Submittal Verification Checklist
3. Application for Storm Water Management Permit
4. Storm Water Management Design Summary Form
5. Certification of Registered Professional Engineer Letter
6. Capacity Certification / Allocation Letter, if required
7. Permit to Tap into the Combined Sewer or Storm Sewer, if required
8. General Site Plan
9. Drainage Plan Report
10. Plans and Specifications
11. Erosion Control Plan
12. Post-Construction Storm Water Management Plan

Four methods of storm water management are permitted. Each method has slightly different permit submittal requirements as noted in the application. The four methods are:

1. Discharge into combined sewers – the storm water system was designed to treat / store / exfiltrate storm water to the maximum extent possible prior to allowing an overflow to a connection into the existing combined sewer system.
2. Discharge into storm sewers – the storm water system was designed to treat / store storm water to the maximum extent practicable prior to allowing an overflow to a connection into the existing storm sewer system.
3. Discharge into waterways – the storm water system was designed to treat / store storm water to the maximum extent practicable prior to allowing an overflow into a swale, ditch, surface water, open waterway, etc.
4. Discharge below grade – the storm water system was designed to treat / store storm water to the maximum extent practicable through below grade exfiltration methods.

All necessary attachments and fees must be completed and submitted. If the application materials are incomplete, a deficiency notice will be provided to the applicant and the application will be retained for 60 days. If sufficient information has not been received within that time period, the application will be denied due to incompleteness.

## 2-5 FEES

Fees are required to be submitted with GSWMD storm water management permits. Fee structures are based on the area of land disturbed as defined in the Storm Water / Sanitary Sewer Fee Submittal Form of the GSWMD Storm Water Management Permit Application (Appendix H of Section 1).

## 2-6 PERMITS

### 2.6.1 GSWMD Storm Water Management Permits

An example storm water management permit and approval letter is provided in Appendix A. Commencement of construction is prohibited until the effective date of the permit. In addition, a storm water management permit must be obtained prior to obtaining a tap permit. Construction shall conform to all provisions of City of Gary Ordinance No. 7309 and all terms and conditions of the permit. The permit must be signed by the applicant expressly agreeing to comply fully with all conditions contained within the permit. Issuance of a permit shall not be construed to guarantee that the proposed storm water management system will meet standards, limitations, or requirements of the GSWMD, GSD, City of Gary, or any agency of this State or the Federal government.

Except to the extent that it may be preempted by State or Federal laws, rules or regulations; the GSWMD may deny the issuance of a permit if it is demonstrated that there is insufficient dry or wet weather capacity in any / all downstream sewers and lift stations, including capacity for pollutants, to accommodate the wasteload expected to be generated as a result of the proposed development.

Once a permit has been issued, no significant or material changes in the scope of the plans or construction of the project shall be made unless the following provisions are met:

1. a request for permit modification is made 60 days in advance of the proposed significant or material changes in the scope of the plans or construction;
2. a detailed statement of such proposed changes is submitted;
3. revised plans and specifications, including a revised permit application, are submitted; and
4. a revised construction permit from the GSWMD is obtained.

The GSWMD may modify, suspend, or revoke the permit for cause, including, but not limited to the following:

1. violation of any term or conditions of the permit; or

2. obtaining the permit by misrepresentation or failure to disclose fully all relevant facts.

### 2.6.2 NPDES General Permit Rule 327 IAC 15-5

327 IAC 15-5 (Rule 5) requires a general permit from the IDEM for construction activities that result in the disturbance of one (1) or more acres of land. Land-disturbing activity is defined as, "any manmade change of the land surface, including removing vegetative cover that exposes the underlying soil, excavating, filling, transporting, and grading" (327 IAC 15-5-4(20)). A Rule 5 permit is also required if a project results in the disturbance of less than one (1) acre of land but is considered part of a "larger common plan of development or sale" (327 IAC 15-5-2(a)(3)).

Rule 5 requires the development of a construction plan and its review and approval by the Lake County Soil and Water Conservation District and the submittal of a Notice of Intent (NOI) letter to the IDEM. Construction activities may not begin prior to Construction Plan approval and submittal of the NOI letter. In addition, once all land disturbing activities have been completed, the entire site has been stabilized, and all temporary erosion and sediment control measures have been removed, the project site owner must: a) prepare a complete NOT, with all required supporting documentation and submit it to the SWCD, and b) receive verification from the SWCD that the project meets the termination requirements as specified in Rule 5.

A letter from the GSWMD listing the specific steps required to ensure compliance with 327 IAC 15-5, including contact information, will be included with the GSWMD Storm Water Management Permit Application. A copy of this letter is provided in Appendix B.

### 2.6.3 EPA Underground Injection Control Program

40 CFR Part 144 (Underground Injection Control Program) requires that basic inventory and assessment information be submitted to U.S. EPA, Region 5 for all Class V wells. Class V wells are defined as, "shallow wells used to place a variety of fluids directly below the land surface", and include, "drainage wells used to drain surface fluids, primarily storm runoff, into a subsurface formation" (40 CFR Part 144.80, Subpart 3, and Part 144.81, Subpart 4). An individual Underground Injection Control (UIC) permit may be required if the injection activity may cause a violation of any primary drinking water regulation in an underground source of drinking water (USDW) or otherwise adversely affect the health

of persons. The completion of a Class V Well Pre-Closure Notification Form is also required for Class V Wells that are to be placed out of service.

The Underground Injection Control Program regulations require that a Class V inventory sheet be completed and submitted for review and approval to the U.S. EPA, Region 5, UIC branch. In some instances, the EPA may also require that a permit be obtained after their review of the inventory sheet. Construction activities may not begin prior to receiving approval from the U.S. EPA, Region 5. In addition, a pre-closure notification form must be submitted to the EPA prior to well closure. A well that is no longer being used must be permanently plugged or closed such that underground sources of drinking water are protected.

A letter from the GSWMD listing the specific steps required to ensure compliance with 40 CFR Part 144, including contact information, will be included with the GSWMD Storm Water Management Permit Application. A copy of this letter is provided in Appendix C.

# CHAPTER 3

# PLANNING

## 3-1 INTRODUCTION

The following chapters focus on the design elements and basic hydraulic criteria necessary for the proper design of storm water management systems. The following chapters also establish the minimum standards and technical design criteria for all storm water management systems within the City of Gary service area and outline common hydrologic policies, practices, and procedures necessary for determining the quantity of storm water runoff for a given watershed.

Sound engineering judgment shall be utilized when determining locations for storm water management systems. Existing easements and rights-of-way shall be utilized if at all possible. Service needs of both the present service area and future service areas should be thoroughly evaluated. The Engineer shall be responsible for the adequacy of the design and shall be a registered professional engineer licensed in the State of Indiana. This implies that the designer will be responsible for not only onsite drainage design, but also upstream and downstream impacts.

## 3-2 PLANNING CONSIDERATIONS

Storm water management facilities control the volume, quality, and release rate of storm water runoff from the developed site once construction is complete and the site is stabilized. The development of a storm water management plan for a site includes the selection of the most appropriate type of facility, method, or combination of methods, to provide quantity and water quality control and is influenced by the physical site conditions, the size of the contributing drainage area, and the water quality and classification of the receiving stream.

Site conditions include topography, soils, slopes, geology, and the location of onsite surface waters, including intermittent and flowing streams and drainageways, ponds, lakes, and wetlands. In addition to the natural features, the site conditions include the existing zoning designation and the land use proposed by the owner / developer.

The size of the site and the contributing drainage area influence the selection of control structures. In general, the use of infiltration-type storm water management structures is limited to smaller drainage areas (generally less than 10 acres), while the use of pond type facilities is limited to larger drainage areas (generally greater than 10 acres) where sufficient base flow to support the permanent pool is available. Soils and topography also influence selection of control methods. For example, infiltration-type structures are limited to sites with sandy or sandy loam soils which are capable of infiltrating the required volumes, and grassed swale-type conveyance systems are only appropriate on sites with gentle slopes so erosive velocities do not scour the bottom of the swale.

Site planning techniques are used to develop a concept plan for a proposed construction activity which accomplishes the long-term land use change objectives of the development within the framework of existing site conditions. Site planning which minimizes disturbed area, reduces the need for mass grading of the site and preserves, to the maximum extent practicable, the natural site topography and drainage features, can reduce the number of sediment control structures and practices necessary to protect receiving waters during construction and can reduce the volume of storage necessary in storm water management structures. Site planning which clusters development in areas most suited to construction allows preservation of more sensitive areas such as onsite streams and wetlands and areas of unstable soils and steep slopes. Cluster development techniques also increase the opportunity to provide undisturbed buffer areas adjacent to onsite streams which can provide water quality benefits.

The concept site plan indicates the proposed location of structures including buildings, roadways, and parking facilities. Using this information and a rough grading plan of the site, storm water management options can be developed. The plan for managing site storm water will include methods of storm water collection, conveyance, and management in control structures, and may include additional control measures which provide water quality improvement as well as quantity control.

In addition to selection of storm water management practices appropriate to site conditions, the overall plan for storm water management must consider the water quality and existing storm water management practices of the entire watershed. Watershed conditions can affect the selection of the method of storm water management quantity control and the level and type of water quality protection provided by the facility.

## 3-3 DESIGN GUIDANCE REFERENCES

The following design guidance materials and references may be used to assist in the design of storm water management systems.


1. *Design and Construction of Urban Stormwater Management Systems*, 1992. ASCE and WPCF, Washington.
2. *Indiana Drainage Handbook*, 1999. Christopher B. Burke Engineering, Ltd, Indianapolis, Indiana.
3. *Indiana Handbook for Erosion Control in Developing Areas*, 1992. Division of Soil Conservation, Indiana Department of Natural Resources, Indianapolis, Indiana.
4. Mays, L.W., 2001. *Stormwater Collection Systems Designs Handbook*. McGraw-Hill, Inc., New York.
5. *Stormwater Drainage Manual*, July 1995. Highway Extension and Research Project for Indiana Counties and Cities, Purdue Research Foundation, West Lafayette, Indiana.
6. *Urban Runoff Quality Management*, 1998. ASCE and WPCF, Washington.
7. USEPA, 1999. *Preliminary Data Summary of Urban Storm Water Best Management Practices.* EPA/821/R-99/012, Washington.

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# CHAPTER 4

# HYDROLOGY

## 4-1 RAINFALL

The hydraulic sizing of storm water management facilities requires estimation of rainfall and peak flow rates. Estimated rainfall design storm information for Gary, Indiana, is provided in Table 4-1.

**Table 4-1. Estimated Rainfall Depths for Gary, Indiana**

| | | | | Frequency | | | |
|---|---|---|---|---|---|---|---|
| **Duration** | **1 Year** | **2 Years** | **5 Years** | **10 Years** | **25 Years** | **50 Years** | **100 Years** |
| 5 minutes | | 0.430 | | | | | 0.81 |
| 15 minutes | | 0.855 | | | | | 1.62 |
| 1 hour | | 1.41 | | | | | 3.10 |
| 2 hours | 1.46 | 1.68 | 2.09 | 2.38 | 2.66 | 2.97 | 3.21 |
| 3 hours | 1.54 | 1.79 | 2.27 | 2.62 | 2.93 | 3.25 | 3.56 |
| 6 hours | 1.79 | 2.14 | 2.65 | 2.98 | 3.49 | 3.85 | 4.22 |
| 12 hours | 2.08 | 2.47 | 3.09 | 3.49 | 3.98 | 4.35 | 4.99 |
| 24 hours | 2.39 | 2.77 | 3.50 | 4.01 | 4.65 | 5.22 | 5.67 |
| 2 days | | 3.20 | 4.10 | 4.69 | 5.40 | 6.10 | 6.55 |
| 4 days | | 3.73 | 4.78 | 5.37 | 6.45 | 6.85 | 7.81 |
| 7 days | | 4.28 | 5.28 | 6.15 | 7.00 | 7.80 | 8.80 |
| 10 days | | 4.65 | 5.85 | 6.63 | 7.95 | 8.85 | 9.20 |

Depths determined from interpolation of graphical data available at:
http://www.in.gov/dnr/water/surface_water/rainfallfrequency/.

Sources:

National Oceanic and Atmospheric Administration, "NOAA Technical Memorandum NWS HYDRO-35, Five to 60 Minute Precipitation Frequency for the Eastern and Central United States", Silver Springs, Maryland, June 1977.

U.S. Weather Bureau, "Technical Paper No. 40, Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years", 1961.

U.S. Weather Bureau, "Technical Paper No. 49, Two to Ten Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States", 1964.

### 4.1.1 Intensity

Chen's Method (Federal Highway Administration, 1976) may be used to generate intensity, duration, and frequency estimates for the design of storm water management systems in the City of Gary. Chen's Method is utilized as follows:

1. Estimate the following values using Table 4-1 or an appropriate rainfall atlas:
   a. 10 year, 1 hour rainfall depth ($p_1^{10}$)
   b. 10 year, 24 hour rainfall depth ($p_{24}^{10}$)
   c. 100 year, 1 hour rainfall depth ($p_1^{100}$)

2. Compute the following parameters:
   a. $Y = (p_1^{10}) / (p_{24}^{10})$
   b. $X = (p_1^{100}) / (p_1^{10})$

3. Estimate the following Chen's Method parameters using the following 5th degree polynomial equations:
   a. $a_1 = -17.60 + [4.418*(Y*100)] - [0.3123*((Y*100)^2)] + [0.01083*((Y*100)^3)] - [0.0001667*((Y*100)^4)] + [0.0000009500*((Y*100)^5)]$
   b. $d' = -11.15 + [1.297*(Y*100)] - [0.06475*((Y*100)^2)] + [0.002036*((Y*100)^3)] - [0.00002996*((Y*100)^4)] + [0.0000001625*((Y*100)^5)]$
   c. $n' = -0.0900 + [0.05945*(Y*100)] - [0.002554*((Y*100)^2)] + [0.00007000*((Y*100)^3)] - [0.0000009583*((Y*100)^4)] + [0.000000005000*((Y*100)^5)]$

4. Determine the intensities corresponding to the 10 year, 1 hour rainfall depth, and the 100 year, 1 hour rainfall depth, $i_1^{10}$ and $i_1^{100}$, respectively. These intensities are equal to $p_1^{10}$ and $p_1^{100}$, respectively (in inches per hour).

5. Calculate a' for the 10 year recurrence interval using the following equation. a' for the 100 year recurrence interval may be calculated similarly by substituting $i_1^{100}$ for $i_1^{10}$.

$$a' = a_1 * i_1^{10} * \log (10^{(2-X)} * T_r^{(X-1)})$$

   where:

   $T_r$ = recurrence interval, years

6. Calculate the 10 year rainfall intensities for several time values using the following rainfall intensity-duration-frequency formula:

$$i_t^{Tr} = a' / (((60 * t) + d')^{n'})$$

where:

$i_t^{Tr}$ = intensity at time t for recurrence interval $T_r$, inches per hour

t = time, hours

An example of the Chen's Method calculations is provided in Figure 4-1.

### 4.1.2 Duration

Storm durations used in conjunction with the Rational Method (Section 4.2.1) shall be equal to or greater than the time of concentration for the watershed being analyzed. If the time of concentration is less than one hour, then the duration shall be one hour.

Storm durations used in runoff hydrograph analyses and routing methods for the design of storm water facilities shall use a storm duration that maximizes the peak discharge for the post-improved site conditions. When designing detention ponds and exfiltration systems, the storm duration that maximizes the required detention / exfiltration volume shall be utilized.

### 4.1.3 Distribution

Storm distributions for hydrograph computations shall be determined by applying the appropriate Huff Distribution for the conditions listed in Table 4-2. Storm distribution data is provided in Appendix D.

**Table 4-2. Huff Distributions for Hydrograph Computations**

| Storm Duration | Distribution |
|---|---|
| 6 hours or less | Huff 1st Quartile |
| 6 hours < Duration <= 12 hours | Huff 2nd Quartile |
| 12 hours < Duration <= 24 hours | Huff 3rd Quartile |
| > 24 hours Duration | Huff 4th Quartile |

## 4-2 RUNOFF

This section provides guidance for standard hydrologic methods used to determine runoff quantities. Runoff quantities shall be computed for the watershed under development and the contributing watershed flowing into or through the watershed. Runoff quantities shall be computed for existing and proposed site conditions.

To address the impacts of the increased peak storm water discharges after development, storm water management facilities are designed to retain the peak storm water runoff from the developed site and control the release rate to a level equal to or less than the peak runoff rate that would have been generated by the site under the pre-development conditions. The volume of storage provided within the facility is controlled by the design storm (amount of rainfall) assumed for calculation of the pre-development and post-development site runoff, and the criteria which specify the allowable release rate.

For storm water systems discharging to combined or storm sewers or waterways, the peak runoff rate after development for the 100 year return period storm must not exceed the pre-development peak runoff rate for the 10 year return period storm. For storm water systems designed to contain / exfiltrate collected storm water, sufficient storage volume must be provided to contain / exfiltrate the peak runoff rate after development for the 100 year return period storm.

### 4.2.1 Rational Method

The Rational Method calculates the runoff flow as the product of rainfall intensity, drainage area, and a coefficient that reflects the combined effects of surface storage, infiltration, and evaporation. Use of the Rational Method for estimation of peak runoff for projects within the City of Gary will be limited to watershed areas 25 acres or less.

Using the Rational Method, the peak rate of runoff is computed as:

$$Q = C * i * A$$

where:

Q = peak rate of runoff, cubic feet per second

C = runoff coefficient, representing the characteristics of the drainage area and defined as the ratio of runoff to rainfall, dimensionless

i = average intensity of rainfall for a duration equal to the time of concentration for a selected rainfall frequency, inches per hour

A = tributary drainage area, acres

It should be noted that the conversion from acres-inches per hour to cubic feet per second is 1.008. This value is usually neglected and it is for these units that the formula was termed "rational".

The basic assumptions used in the application of the Rational Method are:

1. The return period of the peak discharge is the same as that of the rainfall intensity.
2. The rainfall is uniform in space over the watershed under consideration.
3. The storm duration associated with the peak discharge is equal to the time of concentration for the drainage area.
4. The runoff coefficient is not influenced by the return period.
5. The runoff coefficient is independent of the storm duration for a given watershed and reflects any changes in infiltration rates, soil types, and antecedent moisture conditions.

Runoff coefficient values to be used in Rational Method calculations are provided in Table 4-3. The composite "C" value used for a given drainage area with various surface types shall be the weighted average value for the total area calculated from a breakdown of individual areas having different surface types.

**Table 4-3. Rational Method Runoff Coefficients**

| Type of Surface | Runoff Coefficient, "C" |
|---|---|
| Pavement | |
| Asphalt and Concrete | 0.70 – 0.95 |
| Brick | 0.70 – 0.85 |
| Roofs | 0.75 – 0.95 |
| Lawns (sandy) | |
| Flat (0 - 2% slope) | 0.05 – 0.10 |
| Average (2 - 7% slope) | 0.10 – 0.15 |
| Steep (greater than 7% slope) | 0.15 – 0.20 |
| Lawns (clay) | |
| Flat (0 - 2% slope) | 0.13 – 0.17 |
| Average (2 - 7% slope) | 0.18 – 0.22 |
| Steep (greater than 7% slope) | 0.25 – 0.35 |
| Water Impoundment | 1.00 |
| Business | |
| Downtown | 0.70 – 0.95 |
| Neighborhood | 0.50 – 0.70 |
| Residential | |
| Single-family | 0.30 – 0.50 |
| Multi-units, detached | 0.40 – 0.60 |
| Multi-units, attached | 0.60 – 0.75 |
| Suburban | 0.25 – 0.40 |
| Apartment | 0.50 – 0.70 |
| Industrial | |

| | |
|---|---|
| Light | 0.50 – 0.80 |
| Heavy | 0.60 – 0.90 |
| Parks, cemeteries | 0.10 – 0.25 |
| Playgrounds | 0.20 – 0.35 |
| Unimproved | 0.10 – 0.30 |

NOTE: Additional runoff coefficient values are available in the *Stormwater Drainage Manual* (HERPICC, 1994).

### 4.2.2 Soil Conservation Service (SCS) Method

The Soil Conservation Service (SCS) Method is the preferred hydrograph and routing method for the computation of peak runoff rates when the total watershed area tributary to the design point is greater than 25 acres. The SCS Method uses a curve number which depends on soil type, degree of development, and antecedent moisture conditions and includes the effects of infiltration and detention storage. Specific information regarding the use of the SCS Method is available in the *Stormwater Drainage Manual* (HERPICC, 1994).

### 4.2.3 Computer Models

The following computer models may also be utilized in storm water-related calculations.

1. Technical Release No. 55, "Urban Hydrology for Small Watersheds" (TR55)
   TR55 presents simplified procedures to calculate storm runoff volume, peak rate of discharge, hydrographs, and storage volumes required for detention structures. TR55 is public domain software and is available from:
   Natural Resources Conservation Service
   National Water and Climate Center
   101 SW Main Street, Suite 1600
   Portland, Oregon 97204-3224
   http://www.wcc.nrcs.usda.gov/hydro/hydro-tools-models-tr55.html
2. Technical Release No. 20, "Computer Program for Project Formulation Hydrology" (TR20)
   TR20 is a physically based watershed scale runoff event model. It computes direct runoff and develops hydrographs resulting from any synthetic or natural rainstorm. Developed hydrographs are routed through stream and valley reaches as well as through reservoirs. TR20 is public domain software and is available from:
   National Technical Information Service
   U.S. Department of Commerce

5285 Port Royal Road

Springfield, Virginia  22161

(703) 487-4650

http://www.wcc.nrcs.usda.gov/hydro/hydro-tools-models-tr20.html

3. Flood Hydrograph Package (HEC-1)

   HEC-1 is designed to simulate the surface runoff response of a drainage basin to a precipitation input.  The result of the model is the computation of streamflow hydrographs at desired locations.  HEC-1 is public domain software and is available from:

   U.S. Army Corps of Engineers

   Hydrologic Engineering Center

   609 Second Street

   Davis, California  95616-4687

   (530) 756-1104

   http://www.hec.usace.army.mil

4. Hydrologic Modeling System (HEC-HMS)

   HEC-HMS supercedes HEC-1 and provides a similar variety of options for simulating precipitation-runoff processes.  HEC-HMS is public domain software and is available from:

   U.S. Army Corps of Engineers

   Hydrologic Engineering Center

   609 Second Street

   Davis, California  95616-4687

   (530) 756-1104

   http://www.hec.usace.army.mil

5. Storm Water Management Model (SWMM)

   SWMM is a comprehensive watershed-scale model used to represent urban storm water runoff and combined sewer overflow phenomena.  SWMM is public domain software and is available from:

   U.S. Environmental Protection Agency

   Ecosystems Research Division

   Center for Exposure Assessment Modeling

   960 College Station Road

   Athens, Georgia  30605-2700

   (706) 355-8400

   http://www.epa.gov/ceampubl/swater/swmm/index.htm

6. HYDRAIN – Integrated Drainage Design Computer System

   HYDRAIN is a set of programs designed, developed, and approved by the United States Department of Transportation Federal Highway Administration used for storm drain and sanitary sewer analysis and design; bridge waterways and open channel analysis; rainfall estimate, runoff estimate, and hydrograph generation; channel lining stability analysis; and culvert analysis and design. HYDRAIN is public domain software and is available from:

   Federal Highway Administration
   Office of Infrastructure
   Office of Bridge Technology
   400 Seventh Street, SW
   Washington, DC 20590
   (202) 366-4589
   http://www.fhwa.dot.gov/bridge/hydrain.htm

7. StormCAD, PondPack, HEC-Pack, CulvertMaster, FlowMaster

   StormCAD is used for the design and analysis of storm sewer and inlet networks. PondPack analyzes pre- and post-development watershed conditions and sizes ponds and outlets. HEC-Pack can be used to simulate precipitation runoff processes and calculate water surface profiles. CulvertMaster is used for culvert design and analysis. FlowMaster is used for open channel, pipe, and inlet design. These programs are available from:

   Haestad Methods
   37 Bookside Road
   Waterbury, Connecticut 06708
   (203) 755-1666

8. Other computer-based programs, if approved by the GSWMD.

### 4.2.4 Time of Concentration

The time of concentration is generally regarded as the time needed for the furthest regions of a watershed to contribute runoff to the outlet. The time of concentration to be used shall be the sum of the inlet time and flow time in the storm water facility from the most remote part of the drainage area to the point under consideration. The flow time in the storm sewers may be estimated by the distance in feet divided by velocity of flow in feet per second. The velocity shall be determined by Manning's Equation. Inlet time is the combined time required for the runoff to reach the inlet of the storm sewer. Inlet time includes overland flow time and flow time through established surface drainage channels such as swales and ditches and sheet flow across such areas as lawns, fields, and other graded surfaces.

All storm drainage projects shall be designed using one of the time of concentration methodologies outlined in the *Stormwater Drainage Manual* (HERPICC, 1994). One such method utilizes Kerby's Formula, which is

$$t_c = K * (L * N * s^{-0.5})^{0.467}$$

where:

$t_c$ = time of concentration, minutes

K = conversion factor equal to 0.83, dimensionless

L = length of flow (straight line distance) from the most distant point of the watershed to the outlet measured parallel to the slope of the land until a well-defined channel is reached, feet

N = retardance roughness coefficient as shown in Table 4-4, dimensionless

s = average slope of overland flow, feet per foot

**Table 4-4. Kerby's Formula Retardance Roughness Coefficients**

| Type of Surface | Retardance Roughness Coefficient, "N" |
|---|---|
| Smooth impervious surface | 0.02 |
| Smooth bare packed soil | 0.10 |
| Poor grass, cultivated row crops, or moderately rough bare surface | 0.20 |
| Deciduous timberland | 0.60 |
| Pasture or overage grass | 0.40 |
| Conifer timberland, deciduous timberland with deep forest litter or dense grass | 0.80 |

### 4.2.5 Amount of Runoff to be Accommodated

The minor drainage system such as inlets, catch basins, street gutters, swales, sewers, and small channels which collect storm water shall accommodate, as a minimum, peak runoff from a 10 year frequency storm. For Rational Method analysis, the duration shall be equal to the time of concentration for the drainage area unless the time of concentration is less than one hour. In this case the duration shall be equal to one hour. In computer-based analysis, the duration is as noted in the applicable methodology associated with the computer program.

These minimum requirements for minor drainage system components shall be satisfied:

1. The allowable spread of water on collector streets is limited to maintaining two clear 10 feet moving lanes of traffic. One lane is to be maintained on local roads, while other access lanes can have a water spread equal to ½ of their total width.
2. Open channels carrying greater than 30 cubic feet per second shall be capable of accommodating peak runoff for a 24 hour, 50 year return frequency storm within the drainage easement.
3. Culverts shall be capable of accommodating peak runoff from a 24 hour, 50 year return frequency storm.
4. Rear and side lot swales shall not carry more than 4 cubic feet per second and only 2 cubic feet per second if a swale crosses a sidewalk.

### 4.2.6 Offsite Hydrologic Analysis

The design of storm water facilities shall consider and accommodate the drainage of runoff from watersheds tributary to the drainage area(s) being analyzed. Investigation of facilities outside the boundaries of the project area is a required part of the design process, except in cases where oversized detention is provided for runoff traveling through the project area from tributary watersheds.

**Figure 4-1. Chen's Method Rainfall Intensity Calculation Example**

**Step 1:**
**Estimate the following values using Table 4-1 or an appropriate rainfall atlas.**

| | | |
|---|---|---|
| 10 year, 1 hour rainfall depth ($p_1^{10}$) = | **1.98** | **inches** |
| 10 year, 24 hour rainfall depth ($p_{24}^{10}$) = | **4.01** | **inches** |
| 100 year, 1 hour rainfall depth ($p_1^{100}$) = | **3.10** | **inches** |

**Step 2:**
**Compute the following parameters.**

| | |
|---|---|
| $Y = (p_1^{10}) / (p_{24}^{10})$ = | 0.49 |
| $X = (p_1^{100}) / (p_1^{10})$ = | 1.57 |

**Step 3:**

**Estimate the following Chen's Method parameters using Figure 4-1 or the following 5th degree polynomial equations.**

$a_1 = -17.60+[4.418*(Y*100)]-[0.3123*((Y*100)^2)]+[0.01083*((Y*100)^3)]-0.0001667*((Y*100)^4)]+[0.0000009500*((Y*100)^5)]$

$a_1$ = 31

$d' = -11.15+[1.297*(Y*100)]-[0.06475*((Y*100)^2)]+[0.002036*((Y*100)^3)]-[0.00002996*((Y*100)^4)]+[0.0000001625*((Y*100)^5)]$

d' = 9.7

$n' = -0.0900+[0.05945*(Y*100)]-[0.002554*((Y*100)^2)]+[0.00007000*((Y*100)^3)]-[0.0000009583*((Y*100)^4)]+[0.000000005000*((Y*100)^5)]$

n' = 0.8

**Step 4:**
**Determine the intensities corresponding to the 10 year, 1 hour rainfall depth, and the 100 year, 1 hour rainfall depth.**

| | |
|---|---|
| 10 year, 1 hour rainfall intensity ($i_1^{10}$) = | 1.98 inches per hour |
| 100 year, 1 hour rainfall intensity ($i_1^{100}$) = | 3.10 inches per hour |

**Step 5:**
**Calculate a' for the 10 year and 100 year recurrence intervals using the following equations.**

10 year $a' = a_1 * i_1^{10} * \log(10^{(2-X)} * T_r^{(X-1)})$

10 year a' = 61.05

100 year $a' = a_1 * i_1^{100} * \log(10^{(2-X)} * T_r^{(X-1)})$

100 year a' = 95.58

**Step 6:**
**Calculate the 10 year and 100 year rainfall intensities for several time values using the following rainfall intensity-duration-frequency equation.**

$i_t^{Tr} = a' / (((60 * t) + d')^{n'})$

| Storm Duration, t (hours) | 10 year event Intensity, $i_u$ (inches per hour) | 100 year event Intensity, $i_d$ (inches per hour) |
|---|---|---|
| 0.17 | 5.34 | 8.37 |
| 0.25 | 4.44 | 6.96 |
| 0.33 | 3.82 | 5.99 |
| 0.42 | 3.37 | 5.27 |
| 0.50 | 3.02 | 4.72 |
| 0.58 | 2.74 | 4.29 |
| 0.67 | 2.51 | 3.93 |
| 0.75 | 2.32 | 3.64 |
| 0.83 | 2.16 | 3.39 |
| 0.92 | 2.03 | 3.17 |
| 1.00 | 1.91 | 2.98 |
| 2.00 | 1.15 | 1.80 |
| 3.00 | 0.84 | 1.32 |
| 4.00 | 0.67 | 1.05 |
| 5.00 | 0.56 | 0.88 |
| 6.00 | 0.49 | 0.76 |
| 7.00 | 0.43 | 0.68 |
| 8.00 | 0.39 | 0.61 |
| 9.00 | 0.35 | 0.55 |
| 10.00 | 0.32 | 0.51 |

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# CHAPTER 5

## OPEN CHANNELS

### 5-1 SITE SELECTION

An open channel is a conveyance in which the liquid stream is not completely closed by boundaries. The principle types of channels are natural rivers and streams, artificial canals, drainage ditches, sewers, tunnels and pipelines which are not completely filled. Open drainage channels provide surface drainage and must be placed where they will adequately perform their drainage functions. Topography, location of highways, structures, and other obstacles largely fix the location, alignment, and grade of the channel and determine the quantity of surface water entering it.

The grade of the channel affects both the size of the channel required to carry a given flow and the velocity at which the flow occurs. The flow should be subcritical whenever possible. Changes in channel alignment should be as gradual as the width of right-of-way and terrain permit. Whenever practicable, changes in alignment should be made in reaches of the channel which have flatter slopes, particularly if the flow becomes supercritical on the steeper slopes.

### 5-2 DESIGN

Methods based on Manning’s Equation shall be used for the design and analysis of open channels. Manning’s Equation is:

$$Q = (1.486 / n) * A * R^{2/3} * S^{1/2}$$

where:

Q = discharge, cubic feet per second

n = Manning’s roughness coefficient, dimensionless

A = waterway area of channel, square feet

R = hydraulic radius, feet

S = slope of the energy grade line, feet per foot

Open channels, ditches, and swales serving local storm sewers and tributary flows from upstream watersheds shall be designed for a 100 year frequency storm.

## 5-3 CROSS-SECTION AND GRADE

The required channel cross-section and grade are determined by the design capacity, channel construction material, and maintenance requirements. A minimum depth may be required to provide adequate outlets for subsurface drains, tributary ditches, or streams.

The channel grade shall be such that the velocity in the channel is high enough to prevent siltation but low enough to prevent erosion. Velocities less than 1.5 feet per second should be avoided since siltation will take place and ultimately reduce the channel cross-section. Maximum permissible velocities in vegetal-lined channels are dependent on the type of vegetal cover.

## 5-4 SIDE SLOPES

Earthen channel side slopes shall be no steeper than 2 horizontal to 1 vertical (2:1). Flatter slopes may be required to prevent erosion and for ease of maintenance. Where channels will be lined, side slopes shall be no steeper than 1.5:1 with adequate provisions made for weep holes to relieve hydrostatic pressure from groundwater. Side slopes steeper than 1.5:1 may be used for lined channels provided the side lining is designed and constructed as a structural retaining wall with provisions for live and dead load surcharge.

## 5-5 CHANNEL STABILITY

The following conditions shall be considered for the stability of channels:

1. The channel shall not degrade in a manner that adversely affects upstream and downstream capacity and serviceability.
2. Channel banks shall not erode to the extent that the new channel cross-section adversely affects upstream and downstream conveyance capabilities.
3. Excessive sediment depositions shall not develop within the bottom of the channel.
4. Gullies shall not form to allow the entry of uncontrolled surface flow to the channel.

Channel stability shall be determined for an aged condition and the velocity shall be based on the design flow or the bank full flow, whichever is greater, using the appropriate “n” value for the channel lining. It is not necessary to check channel stability for discharges greater than that from a 100 year frequency storm.

## 5-6 CHANNEL LINING

At minimum, the peak discharge from the 10 year design storm shall be used to design channel linings for all channels. The following materials are acceptable for use as channel lining:

1. grass,
2. revetment riprap,
3. concrete,
4. hand laid riprap,
5. precast cement concrete riprap,
6. grouted riprap,
7. gabions, and
8. mattings (straw or coconut).

Materials used for channel linings shall comply with the appropriate INDOT Standard Specifications.

## 5-7 DRAINAGE

Vegetated waterways that are subject to low flows of long duration or where wet conditions prevail shall be drained with a tile system or by other means such as paved gutters. Tile lines may be outletted through a drop structure at the ends of the waterway or through a standard tile outlet.

## 5-8 APPURTENANT STRUCTURES

The design of channels shall include provisions for operation and maintenance and the proper functioning of all channels, laterals, travelways, and structures associated with the project. Recessed inlets and structures needed for entry of surface and subsurface flow into channels without significant erosion or degradation shall be included in the design of channel improvements. The design will also provide for necessary flood gates, water level control devices, and any other appurtenance structure affecting the functioning of the channels and the attainment of the purpose for which they are built.

The effects of channel improvements on existing culverts, bridges, buried cables, pipelines, and inlet structures for surface and subsurface drainage on the channel being improved and laterals thereto shall be evaluated to determine the need for modification or replacement.

# CHAPTER 6

# CATCH BASINS, INLETS, AND OTHER STRUCTURES

## 6-1 GUTTER FLOW AND INLET DESIGN

### 6.1.1 General

In many drainage systems, storm water enters the conveyance system through an inlet. Often these openings are located along a gutter which is designed to convey overland flow to the inlets. These inlets may be located directly in the gutter, curb, or in both the curb and gutter. It is important that the gutter and inlet be properly designed to adequately collect the storm water in order to minimize potential flooding of the roadway, danger to pedestrians, and disruption of traffic.

The basis for inlet design is to control the spacing of storm water inlets to effectively maintain a drivable lane on local streets and two drivable lanes on arterial and collector streets.

### 6.1.2 Flow in Gutters

Gutters are used to convey surface runoff into an inlet or other opening so that it may eventually enter the drainage system. The depth of water in the gutter and the top width of the water surface on the street are important design parameters.

The capacity or width of flow in street sections may be calculated for triangular-shaped gutter sections using the following modified form of Manning's Equation:

$$Q = (0.56 * S_X^{1.67} * S_L^{0.50} * T^{2.67}) / n$$

where:

$Q$ = flow, cubic feet per second

$S_X$ = pavement cross slope, feet per foot

$S_L$ = average longitudinal slope of gutter, feet per foot

T = top width of flow extending from face of curb to street, feet

n = Manning's roughness coefficient, dimensionless

The following relationship shall be used to determine the depth of flow in triangular-shaped gutters:

$$d = T * S_X$$

where:

d = depth of gutter flow, feet

T = top width of flow extending from face of curb to street, feet

$S_X$ = pavement cross slope, feet per foot

### 6.1.3 Maximum Width of Gutter Flow

The minimum longitudinal slope of the gutter, $S_L$, shall be 0.4 percent. The minimum transverse slope of the street, $S_x$, shall be 1 percent. Table 6-1 lists maximum widths of gutter flow from the face of the curb to the street, T, for use during inlet spacing analysis.

**Table 6-1. Maximum Gutter Flow Width**

| Street Width (feet) | Maximum Allowable Width of Flow, T (feet) |
|---|---|
| Less than 27 | 7 |
| 27 to 40 | 8 |
| Greater than 40 | 9 |

NOTE: For areas with rolled curb, 6 inches shall be added to the maximum allowable width of flow and measurements shall be taken to the back of the curb.

### 6.1.4 Inlet Location and Spacing of Inlets

Inlets shall be utilized to collect surface water through grated openings and convey it to storm sewers, channels or culverts. The following requirements relate to inlet design:

1. Inlets shall be provided in all sag or sump locations. A sufficient number of inlets shall be installed to conform with the width of flow requirements defined above.
2. Inlets placed in locations other than sags shall be designed to intercept at least 75 percent of tributary design flow. Bypass flow, i.e., flow not intercepted by an individual grate, shall not

exceed 25 percent and shall be considered when determining the location of the next downstream grate.

3. General spacing between inlets is 300 to 600 feet, provided the maximum width listed in Table 6-1 is not exceeded.
4. Inlets for newly designed storm sewers shall be placed immediately upstream of pedestrian walkways, handicap ramps, and intersections, and shall be designed to intercept 100 percent of tributary flow. If a low point exists before the walkway, ramp, or intersection, flows may be intercepted before these identified points. Inlets that are required shall be placed a minimum of 2 feet from the edge of walkways, handicap ramps, and driveways.
5. Combination inlets are desirable, especially at low points, because the curb opening provides relief from flooding if the grate becomes clogged. If the gutter grate is efficient, the combination inlet will have a capacity only slightly greater than a similar inlet with grate alone. Hence, only the grate capacity shall be considered when designing a combination inlet.
6. The inlet should be able to pass small debris, e.g., leaves, while screening out larger, harmful debris, e.g., tree branches.
7. The inlet should have sufficient strength to resist traffic loadings.
8. Inlet grates should not be hazardous to bicycles.
9. Inlets shall be designed for a 10 year frequency storm, at a minimum.

### 6.1.5 Inlet Design Capacity

#### *6.1.5.1 General Inlets on a Continuous Grade*

For inlets placed on a continuous grade, the inlet capacity, $Q_i$, shall be calculated using the following equation:

$$Q_i = K * d^{5/3}$$

where:

$Q_i$ = inlet capacity, cubic feet per second

K = inlet grate constant based on grate geometry and longitudinal and transverse slopes (provided by manufacturer), dimensionless

d = maximum depth of flow, feet

#### *6.1.5.2 Inlets in Sump or Sag Condition*

For inlets placed in a sump condition, the rate of flow, $Q_i$, into the inlet is determined by the depth of water above the grate. Open back inlets shall be placed in all sags.

For depths above the inlet grate of 0.3 feet and less (weir flow), the rate of flow shall be calculated using the following equation:

$$Q_i = 3.30 * P * d^{1.5}$$

where:

$Q_i$ = rate of flow into inlet, cubic feet per second

K = perimeter of grate, feet

d = depth of water surface above inlet, feet

For depths above the inlet grate above 0.3 feet (orifice flow), the rate of flow shall be calculated using the following equation:

$$Q_i = 4.81 * A * d^{0.5}$$

where:

$Q_i$ = rate of flow into inlet, cubic feet per second

A = net open area of grate, square feet

d = depth of water surface above inlet, feet

## 6-2 STANDARD SPECIFICATIONS

### 6.2.1 Materials

#### *6.2.1.1 Concrete Catch Basins and Box Inlets*

All standard inlets shall be constructed of reinforced precast concrete sections. Joints between sewer pipe and inlet walls shall be sealed with non-shrink grout.

Precast concrete inlets shall be constructed in accordance with ASTM C478. Adjustment to final grade of inlet casting shall be accomplished by utilizing precast concrete adjusting rings. Adjusting rings, when required, shall be sized to adjust to final grade by using a maximum of 3 adjusting rings. Adjusting rings shall be limited to less than 1 foot of inlet depth.

All inlet joints, along with the adjusting rings and top casting are to be sealed with ½ inch extrudable gasket (Kent Seal, or equal) to produce soil-tight joint.

Precast box inlets shall be constructed in accordance with Indiana Department of Transportation Standard Specifications.

#### *6.2.1.2 Castings*

The type of casting used shall consider the required square footage of open area needed to convey the estimated storm water flow and be bicycle friendly. Castings shall be of uniform quality, free from blow holes, porosity, hard spots, shrinkage, distortion, or other defects. Castings shall be smooth and well-cleaned by shot blasting or other approved method. All castings shall be manufactured true to pattern, i.e., component parts shall fit together in a satisfactory manner. Round frames and covers shall be of non-rocking design or shall have machined horizontal bearing surfaces to prevent rocking and rattling under traffic. The following castings are approved for use.

1. Beehive Casting
    a. Frame and Grate: Neenah R-2560-D8 or East Jordan 1130 01
2. Alley Casting
    a. Frame: Neenah R 3036-B or East Jordan 5105
    b. Grate: Type A or S
3. Curb and Gutter Grate
    a. Frame: Neenah R 3010 or East Jordan 7010
    b. Grate: Sinusoidal
4. Curb and Gutter Casting
    a. Frame: Neenah R 3067 or East Jordan 7030 M5
    b. Grate: Vane
5. Beehive Grate
    a. Frame and Grate: Neenah R-4215-C or East Jordan 6610

#### *6.2.1.3 Underdrains*

The following materials shall be acceptable for underdrains:

1. Corrugated polyethylene tubings and fittings, four-inch to six-inch according to ASTM F405.
2. Corrugated polyethylene tubings and fittings, eight-inch to 24-inch according to AASHTO M294.
3. Corrugated PVC tubing and compatible fittings according to AASHTO M252.
4. PVC corrugated sewer pipe with smooth interior walls and fittings, four-inches to eighteen-inches according to ASTM F949.
5. PVC pipe according to ASTM D3033 and ASTM D3034.

### 6.2.2 Installation and Construction

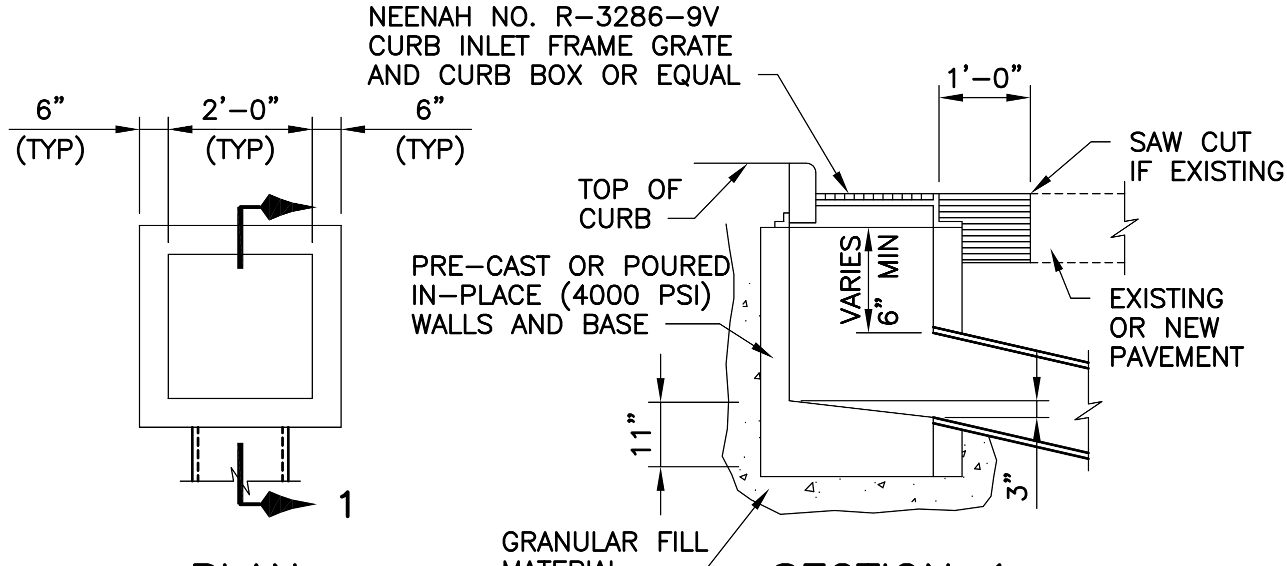
Precast reinforced concrete sections shall be laid in mortar, composed of one part cement to three parts sand, by volume, based on dry materials, or on an approved mastic material.

Castings placed on concrete or precast concrete surfaces shall be set in full mortar beds. The mortar shall be mixed in proportions of one part cement to three parts sand, by volume, based on dry materials. Castings shall be set accurately to the finished elevation.

All newly constructed catch basins, inlets and special structures shall be cleaned of any accumulation of silt, debris, or foreign matter of any kind, and shall be free from such accumulations at the time of final inspections.

## 6-3 STANDARD DETAILS

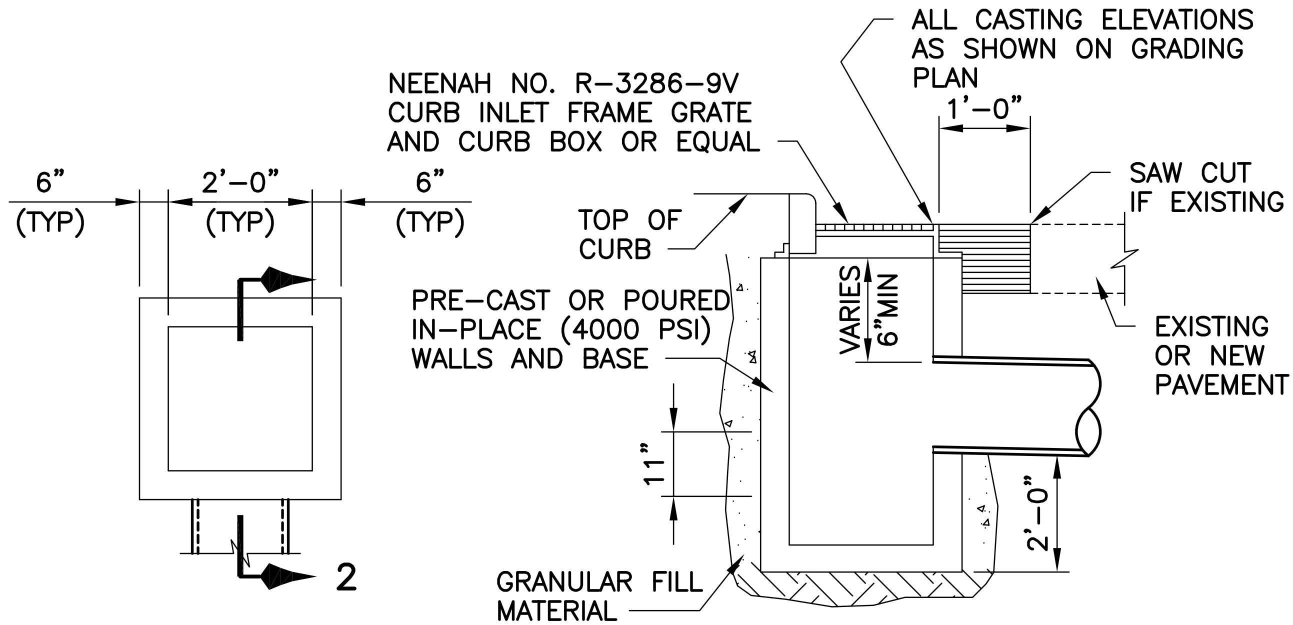
| Standard Detail Title | Figure Number |
|---|---|
| Storm Sewer Curb Inlet and Catch Basin Details | 6-1 |




PLAN

SECTION 1

## CURB INLET




PLAN

SECTION 2

## CURB CATCH BASIN

# STORM SEWER CURB INLET AND CATCH BASIN DETAILS

| NO. | REVISION | DATE |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

CITY OF GARY, INDIANA
DEPARTMENT OF PUBLIC WORKS
GARY SANITARY DISTRICT
GARY STORM WATER MANAGEMENT DISTRICT

FIGURE

6-1

FILE: J:\Projects\03304 GSD Standards Manual\06 Studies\6.8 Report Dwgs\SEC_2-FIG_06-1 1:1 09/22/04 16:32 GH-H

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# CHAPTER 7

## STORM WATER STORAGE

### 7-1 PURPOSE

The purpose of this chapter is to define the minimum requirements for storage facilities to control runoff and its impacts caused by land altering activities.

### 7-2 TYPES OF RUNOFF STORAGE FACILITIES

The release rate from a storm water detention system (designed to slow and temporarily hold storm water runoff so it can be released at a controlled rate) shall be no greater than the capacity of the downstream outlet whether it be a storm drainage structure, combined sewer, storm sewer, channel, waterway, or other.

The purpose of a storm water retention system is to capture / treat / store storm water runoff in a designated area where it is allowed to percolate / infiltrate into the ground through a series of specially designed subsurface perforated structures. Ideally, a storm water retention system will not utilize a downstream outlet. However, if a storm water retention system will have a downstream outlet, it shall be designed according to the detention requirements herewith.

The following types of storage facilities are acceptable for use within the City of Gary:

1. natural depression storage,
2. detention basins,
3. retention basins,
4. parking lot storage, and
5. infiltration.

## 7-3 RUNOFF STORAGE REQUIREMENTS AND ALLOWABLE RELEASE RATES

The minimum capacity for newly-designed runoff storage facilities shall be the 100 year runoff from the undeveloped site (runoff rate for the entire basin cannot increase) for the design watershed with an allowable release rate meeting the criteria below. The designer is entitled to consider offsite runoff at its existing rate.

Singular peak release rates for newly-designed storage facilities shall discharge at a maximum rate of 0.18 cubic feet per second per acre (approximately the 5 year discharge rate from an average predeveloped site), but lacking further significant restriction for smaller, more frequent storm events. Graduated peak release rates for newly-designed storage facilities shall discharge at a maximum rate of 0.18 cubic feet per second per acre (approximately the 5 year discharge rate from an average predeveloped site) that graduates down to not greater than 0.05 cubic feet per second per acre (approximately the 2 year discharge rate from an average predeveloped site) during 10 year storm events.

In the event the natural downstream channel or storm sewer system is inadequate to accommodate the release rate provided above, then the allowable release rate shall be reduced to that rate permitted by the capacity of the receiving downstream channel or sewer system and additional detention as determined by the GSWMD shall be required to store that portion of the runoff exceeding the capacity of the receiving sewers or waterways.

If more than one detention / retention facility is involved in the development of the area upstream of the limiting restriction, the allowable release rate from any one detention basin shall be in direct proportion to the ratio of its drainage area to the drainage area of the entire watershed upstream of the restriction.

## 7-4 METHODS FOR THE DETERMINATION OF RUNOFF STORAGE VOLUMES

The Rational Method based on runoff from a 100 year return period storm shall be used to compute storage volumes for sites receiving flow from watersheds less than or equal to 25 acres in size. The Rational Method is used to determine the maximum storage required for a drainage area by determining the difference between the inflow rate and the peak outflow rate, or allowable release rate, permitted to leave the basin.

The required storage volume for sites with watershed areas greater than 25 acres shall be computed by manual storage routing methods or by computer modeling programs designed to analyze storage facilities, subject to the approval of the GSWMD.

The following procedure, based on the Rational Method, may be used to determine the required storage volume.

1. Estimate the total drainage area, $A_u$, along with a breakdown of area per existing land use, to calculate the composite runoff coefficient, $C_u$, of the site.
2. Estimate the total drainage area, $A_d$, along with a breakdown of area per developed conditions, to calculate the composite runoff coefficient, $C_d$, of the site.
3. Estimate the time of concentration of the site, $t_c$, based on existing land use. Kerby's Formula, as discussed in Section 4.2.4, may be used for this estimation. If the time of concentration is less than one hour, $t_c$ shall be one hour.
4. Calculate the 10 year rainfall intensity, $i_u$, for a storm duration equal to the time of concentration, $t_c$. Chen's Method, as discussed in Section 4.1.1, may be used for this calculation.
5. Calculate the runoff, $Q_u$, based on existing land use using the Rational Method ($Q_u = C_u * i_u * A_u$) as discussed in Section 4.2.1. This value is the allowable outflow rate from the site, $O(t_d)$.
6. Calculate the 100 year rainfall intensity, $i_d$, for various storm durations, $t_d$. Recommended durations are 10, 15, 20, 25, 30, 35, 40, 45, 50, and 55 minutes, and 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 hours. Chen's Method, as discussed in Section 4.1.1, may be used for this calculation.
7. Calculate the runoff, $Q_d$, based on developed conditions for each storm duration, $t_d$, using the Rational Method ($Q_d = C_d * i_d * A_d$) as discussed in Section 4.2.1. These values are equal to the inflow rates to the site for each storm duration, $I(t_d)$.
8. Calculate the storage rate, $S(t_d)$, for each storm duration, $t_d$, using the following equation.

$$S(t_d) = Q_d - Q_u = I(t_d) - O(t_d)$$

   where:

   $S(t_d)$ = storage rate at storm duration, $t_d$, cubic feet per second

   $I(t_d)$ = inflow rate at storm duration, $t_d$, cubic feet per second

   $O(t_d)$ = outflow rate at storm duration, $t_d$, cubic feet per second

9. Calculate the required storage volume, $S_R$, for each storm duration, $t_d$, using the following equation.

$$S_R = S(t_d) * (t_d / 12)$$

   where:

   $S_R$ = required storage volume at storm duration, $t_d$, acre - feet

$S(t_d)$ = storage rate at storm duration, $t_d$, cubic feet per second

$t_d$ = storm duration, hours

10. Select the largest required storage volume calculated in Step 9. This volume shall be used for storage facility design.

An example of a storage facility volume calculation is provided in Figure 7-1.

## 7-5 PHYSICAL CHARACTERISTICS FOR RUNOFF STORAGE FACILITIES

### 7.5.1 General Design Criteria

A summary of the basic design criteria parameters for detention facilities is provided in Table 7-1:

**Table 7-1. General Design Criteria for Detention Facilities**

| Facility | Maximum Side Slope | Maximum/Minimum Water Depth (feet) | Minimum Top Width of Embankment (feet) | Minimum Maintenance Access Width (feet) |
|---|---|---|---|---|
| Detention (dry) Basin | 4:1 (H:V) | Maximum 4 – 6 | 8 | 10 |
| Detention (wet) Pond | 4:1 (H:V) | Minimum pool 10 | 8 | 10 |
| Parking Lot | - | 1 at inlet; 6 inches at 10 from inlet | - | - |

NOTE: A 10 feet maintenance access width area is required for all detention facilities. The access width area shall consist of a 10 feet wide all-weather surface for emergency and maintenance vehicle access. This access width area does not need to be present around the entire detention facility.

#### *7.5.1.1 Detention Basins*

In general, all detention basins shall be designed to conform to the following requirements:

1. All detention basins shall have a minimum of 1 foot of freeboard above the design high water elevations.
2. The maximum volume of water stored and subsequently released at the design release rate shall not result in a storage duration in excess of 48 hours from the start of the storm unless additional storms occur within the period.
3. Facilities should have no earthen side slopes steeper than 4 feet horizontal to 1 foot vertical.
4. For residential developments, the maximum planned depth of storm water stored (without a permanent pool) shall not exceed 4 feet.

5. All storm water detention facilities shall be separated by not less than 25 feet from any building or structure to be occupied.
6. An overflow spillway or weir should be placed at the high water elevation. The spillway should provide the capacity to convey the peak 100 year flow plus adequate freeboard, and shall discharge to a properly planned and protected overflow outlet path. The overflow shall be of such design that its operation is automatic and does not require manual attention.
7. Side slopes should be thoroughly seeded or sodded with a suitable amount of topsoil. Seed and sod should be capable of withstanding periodic flooding. Vegetative cover shall be provided throughout the entire detention storage basin area.
8. Outlets which discharge overland or to open channels should be provided with riprap or other materials to prevent erosion.
9. Screens or bars having a maximum opening of 4 inches should be placed over all inlets and outlets that are six inches or more in diameter to protect children and animals and to collect debris.
10. Trash racks should be provided at a sufficient angle to inhibit plugging. Bar spacing on all racks shall be designed to consider the diameters of inlet and outlet piping.
11. Submerged outlets can be utilized; therefore, eliminating the need for inlet and outlet screens and trash racks.
12. Danger signs shall be mounted at appropriate locations to warn of deep water, possible flood conditions during storm periods, and other dangers that exist. Fencing shall be provided if deemed necessary by the GSWMD. Unbuffered proximity to heavily-traveled roadways and sidewalks must be avoided.
13. Debris and trash removal and other necessary maintenance shall be performed on a regular basis to assure continued operation in conformance to design.
14. No detention facility or other water storage area, permanent or temporary, shall be constructed under or within 10 feet of any pole or high voltage electric line.
15. No residential lots, or any part thereof, shall be used for any part of a detention basin or for the storage of water, either temporary or permanent.
16. Whenever possible, the basin shall be designed to serve secondary or multi-purpose functions. Recreational facilities, aesthetic qualities, or other types of uses shall be considered in detention facility planning.
17. To maximize water quality benefits, the pond inlet and outlet should be located on opposite ends to provide the maximum settling time within the basin to encourage settling of suspended solids.
18. Access must be provided to all outlet control structures and spillways.

### *7.5.1.2 Dry Bottom Basins*

In addition to the requirements in Section 7.5.1.1, dry bottom basins which will not contain a permanent pool of water shall be designed to conform to the following requirements:

1. Provisions shall be incorporated to facilitate complete interior drainage and dewatering of dry bottom basins.
2. Basins shall include minimum longitudinal grades of ½ percent to outlet structures and 2 percent transverse grades from perimeter areas.
3. An underdrain system should be constructed to minimize the wetness of dry bottom basins. An alternative to the underdrain system is sloping of the pond bottom with at least a 2 percent grade from inlet to outlet.
4. Lined low flow channels or gutters shall be considered in basins where wetness is a consideration.

### *7.5.1.3 Wet Bottom Basins*

In addition to the requirements in Section 7.5.1.1, wet bottom basins which will contain a permanent pool of water shall be designed to conform to the following requirements:

1. The recommended basin wet area is at least ½ acre.
2. A minimum normal depth, calculated as the deepest point of the basin, shall be 10 feet.
3. A stilling and sedimentation basin shall be installed at major inlets for the pond to draw sediment and other suspended materials from flow.
4. A minimum 5 feet wide earthen safety ledge should be installed within the outer periphery of the pond 18 inches below the permanent water level, transitioning to a slope not steeper than 3 feet horizontal to 1 foot vertical to the center of the pond.
5. A safety ramp exit from the basin shall be required in all cases and shall have a minimum width of 20 feet and exit slope of 6 horizontal to 1 vertical (6:1). The ramp shall be of a material that will prevent its deterioration due to vehicle use or erosion.
6. No wet bottom detention basins shall be constructed within a 1 mile radius of airport property.
7. Periodic maintenance is required in basins to control weed and larval growth.
8. The facility shall be designed to provide for the easy removal of sediment which will accumulate during periods of reservoir operation.
9. A means of maintaining the designed water level of the basin during prolonged periods of dry weather is required.

10. Facilities shall be provided or maintenance plans shall be developed for auxiliary equipment to permit emptying of the permanent pool for emergency maintenance, basin cleaning, or shoreline maintenance.

### *7.5.1.4 Parking Lot Storage*

Paved parking lots may be designed to provide temporary detention storage of storm waters on all or a portion of their surfaces. The design of storage in parking lots and adjacent areas shall conform to the following requirements:

1. Outlets shall be designed so as to empty the stored waters slowly.
2. Storage areas in parking lots should be restricted to remote locations that cause the least inconvenience to users. Multistage storage may be considered in parking lot areas.
3. Depths of storage shall be limited to a maximum depth of 7 inches so as to prevent damage to parked vehicles and so that access to parked vehicles is not impaired.
4. Emergency overland flow routes shall be established for flood events that fill the storage volume. The elevation of these routes must be lower than the elevation of surrounding buildings, and when practical, adjacent intersections.
5. The parking lot should be drained in at most 30 minutes after the end of rainfall.
6. Frequent maintenance should be provided to ensure that drain openings do not plug.

### *7.5.1.5 Infiltration*

The temporary storage and subsequent infiltration of storm water into soil may be accomplished through the use of a basin, trench, porous asphalt, or perforated pipe. The rate at which the water can percolate through the soil depends upon the soil makeup and the location of the groundwater table.

The soil permeability is a measure of the ability of the soil to allow infiltration. Coefficient of permeability, K, values for projects utilizing infiltration shall be field-determined. Darcy's Law can be used to determine the flow rate:

$$Q' = A' * K * h_L$$

where:

$Q'$ = flow rate, cubic feet per second

$A'$ = cross-sectional area of soil through which the water flows, square feet

$K$ = coefficient of permeability, feet per second

$h_L$ = headloss or the gradient over a flow distance, L, feet per foot

The procedure used to determine the storage / infiltration requirement is outlined below.

1. Calculate the volume of accumulated runoff for a given time increment, $t_d$, for the storm duration using the Rational Method.
2. Calculate the allowable release volume which does not have to be infiltrated, if any.
3. Calculate the volume of the water flowing through the soil at time $t_d$ using Darcy's Law. A safety factor of 2 shall be used by dividing Q' by 2.
4. The difference between the inflow volume and the allowable release rate and infiltrated volume is the required storage.
5. The largest required storage when all the durations are considered is the design requirement.
6. The basin, trench, or pipe should have a void volume equal to the maximum required storage.

An example of an infiltration calculation is provided in Figure 7-2.

### 7.5.2 Outlet Control Devices

The design of any detention facility requires that the outflow be regulated to a maximum flow rate. This is usually accomplished using an orifice, weir, or pipe. The outflow control device must be designed so the facility does not exceed the maximum storage facility capacity or the capacity of downstream outlets.

### 7.5.3 Spillways, Embankments, Levees, and Dams

Materials used for the construction of spillways, embankments, levees, and dams shall be limited to concrete or compacted clay and shall be resistant to seepage. Dams and levees constructed to protect areas not regulated by the USACOE shall be designed in accordance with USACOE standards. Each facility shall be provided with materials necessary to inhibit erosion.

Spillways shall be designed using a weir or drop inlet structure(s) for the outfall. The spillway shall be designed and constructed to be resistant to erosion and blockage caused by debris and high velocity flows.

## 7-6 STANDARD DETAILS

| Standard Detail Title | Figure Number |
|---|---|
| Perforated Pipe Trench Detail | 7-3 |
| Standard Pre-Cast Perforated Dry Well | 7-4 |

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**Figure 7-1. Storage Facility Volume Calculation Example**

**Step 1:**

**Estimate the total drainage area, $A_u$, along with a breakdown of area per existing land use, to calculate the composite runoff coefficient, $C_u$, of the site.**

| Land Use | Area ($A_u$) | | Percent of Land Use | $C_u$ | Composite $C_u$ |
|---|---|---|---|---|---|
| Asphalt | 400 sq. ft. | 0.009 acres | 0.1% | 0.90 | 0.00 |
| Concrete | 1,000 sq. ft. | 0.023 acres | 0.1% | 0.85 | 0.00 |
| Roof | 200 sq. ft. | 0.005 acres | 0.0% | 0.90 | 0.00 |
| Unimproved | 250,000 sq. ft. | 5.739 acres | 33.3% | 0.30 | 0.10 |
| Lawn/Grasses | 500,000 sq. ft. | 11.478 acres | 66.5% | 0.10 | 0.07 |
| Total | 751,600 sq. ft. | **17.254 acres** | 100.0% | - | **0.17** |

**Step 2:**

**Estimate the total drainage area, $A_d$, along with a breakdown of area per developed conditions, to calculate the composite runoff coefficient, $C_d$, of the site.**

| Land Use | Area ($A_d$) | | Percent of Land Use | $C_d$ | Composite $C_d$ |
|---|---|---|---|---|---|
| Asphalt | 245,000 sq. ft. | 5.624 acres | 32.6% | 0.90 | 0.29 |
| Concrete | 5,400 sq. ft. | 0.124 acres | 0.7% | 0.85 | 0.01 |
| Roof | 501,000 sq. ft. | 11.501 acres | 66.7% | 0.90 | 0.60 |
| Unimproved | 0 sq. ft. | 0.000 acres | 0.0% | 0.30 | 0.00 |
| Lawn/Grasses | 200 sq. ft. | 0.005 acres | 0.0% | 0.20 | 0.00 |
| Total | 751,600 sq. ft. | **17.254 acres** | 100.0% | - | **0.90** |

**Step 3:**
**Estimate the time of concentration of the site, $t_c$, based on existing land use.**

$t_c = K * (L * N * s^{-0.05})^{0.467}$

| | | |
|---|---|---|
| Conversion factor (K) = | 0.83 | dimensionless |
| Retardance roughness coefficient (N) = | 0.40 | dimensionless |
| Average slope of overland flow (s) = | 0.00617 | feet per foot |
| Length of flow (L) | 37,550 | feet |
| Time of concentration ($t_c$) = | **243.0** | **minutes** |

**Step 4:**
**Calculate the 10 year rainfall intensity, $i_u$, for a storm duration equal to the time of concentration, $t_c$.**

| | | |
|---|---|---|
| 10 year rainfall intensity at $t_c$ duration ($i_u$) = | 0.67 | inches per hour |

**Step 5:**

**Calculate the runoff, $Q_u$, based on existing land use using the Rational Method. This value is the allowable outflow rate from the site, $O(t_d)$.**

| | | |
|---|---|---|
| Allowable outflow rate ($Q_u = O(t_d)$) = | 1.932 | cubic feet per second |

**Step 6:**
**Calculate the 100 year rainfall intensity, $i_d$, for various storm durations, $t_d$, using Chen's Method.**

**Step 7:**
**Calculate the runoff, $Q_d$, based on developed conditions for each storm duration, $t_d$, using the Rational Method. These values are the inflow rates to the site for each storm duration, $I(t_d)$.**

$$I(t_d) = C_d * i_d * A_d$$

**Step 8:**
**Calculate the storage rate, $S(t_d)$, for each storm duration, $t_d$.**

$$S(t_d) = I(t_d) - O(t_d)$$

**Step 9:**
**Calculate the required storage volume, $S_R$, for each storm duration, $t_d$.**

$$S_R = S(t_d) * t_d * 3{,}600$$

| Storm Duration, $t_d$ (hours) | 100 Year Rainfall Intensity, $i_d$ (inches per hour) | Inflow Rate, $I(t_d)$ (cfs) | Storage Rate, $S(t_d)$ (cfs) | Required Storage, $S_R$ (cubic feet) |
|---|---|---|---|---|
| 0.17 | 8.37 | 129.8 | 127.9 | 76,739 |
| 0.25 | 6.96 | 108.0 | 106.0 | 95,429 |
| 0.33 | 5.99 | 92.9 | 91.0 | 109,152 |
| 0.42 | 5.27 | 81.8 | 79.9 | 119,830 |
| 0.50 | 4.72 | 73.3 | 71.4 | 128,477 |
| 0.58 | 4.29 | 66.5 | 64.6 | 135,686 |
| 0.67 | 3.93 | 61.0 | 59.1 | 141,831 |
| 0.75 | 3.64 | 56.4 | 54.5 | 147,160 |
| 0.83 | 3.39 | 52.5 | 50.6 | 151,845 |
| 0.92 | 3.17 | 49.2 | 47.3 | 156,011 |
| 1.00 | 2.98 | 46.3 | 44.4 | 159,750 |
| 2.00 | 1.80 | 27.9 | 26.0 | 186,900 |
| 3.00 | 1.32 | 20.4 | 18.5 | 199,958 |
| 4.00 | 1.05 | 16.3 | 14.4 | 207,426 |
| 5.00 | 0.88 | 13.7 | 11.8 | 211,863 |
| 6.00 | 0.76 | 11.9 | 9.9 | 214,385 |
| 7.00 | 0.68 | 10.5 | 8.6 | 215,580 |
| 8.00 | 0.61 | 9.4 | 7.5 | 215,800 |
| 9.00 | 0.55 | 8.6 | 6.6 | 215,270 |
| 10.00 | 0.51 | 7.9 | 5.9 | 214,143 |

**Step 10:**
**Select the largest required storage volume calculated in Step 9. This volume shall be used for storage facility design.**

| Required storage volume = | |
|---|---|
| | **4.95 acre-feet** |
| | **215,800 cubic feet** |

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**Figure 7-2. Infiltration Calculation Example**

**Step 1:**
**Determine site soil conditions.**

| | | |
|---|---|---|
| Groundwater elevation, $Z_{gw}$ = | 600.00 | feet |
| Coefficient of permeability, K = | 0.000951 | feet per second |
| Hydraulic gradient, $h_L$ = | 1.25 | feet per foot |
| Safety factor, SF = | 2 | |

**Step 2:**
**Calculate the perforated pipe and trench storage volume.**

| | | |
|---|---|---|
| Top of stone elevation, $Z_t$ = | 604.00 | feet |
| Bottom of stone elevation, $Z_b$ = | 601.50 | feet |
| Width of stone trench, W = | 5.00 | feet |
| Void ratio of stone, n = | 0.4 | |
| Perforated pipe diameter, D = | 15 | inches |
| Perforated pipe length, L = | 2,530 | feet |
| Perforated pipe invert elevation, $Z_p$ = | 602.00 | feet |
| Perforated pipe storage volume, $S_p = (PI * D^2) / ((2 * 12)^2)$ = | 1.23 | cubic feet per foot |
| Trench storage volume, $S_t = (((Z_t - Z_b) * W) - S_p) * n$ | 4.51 | cubic feet per foot |
| Total incremental storage volume available, $S_i = S_p + S_t$ | 5.74 | cubic feet per foot |
| Total storage volume available, $S_{pp} = S_i * L$ | **14,513** | **cubic feet** |

**Step 3:**
**Calculate the perforated pipe and trench exfiltration rate.**

| | | |
|---|---|---|
| Exfiltration cross-sectional area, $A = (Z_t - Z_b) * 2$ | 5.00 | sq. feet per foot |
| Incremental exfiltration rate, $O_i = (K * h_L * A) / SF$ | 0.0030 | cubic feet per second per foot |
| Total perforated pipe and trench exfiltration rate, $O_{pp} = O_i * L$ | **7.522** | **cubic feet per second** |

**Step 4:**
**Calculate the dry well and trench storage volume.**

| | | |
|---|---|---|
| Top of dry well elevation, $Z_t$ = | 605.60 | feet |
| Bottom of dry well elevation, $Z_b$ = | 602.50 | feet |
| Diameter of stone trench, $D_t$ = | 96 | inches |
| Void ratio of stone, n = | 0.4 | |
| Dry well diameter, D = | 60 | inches |
| Number of dry wells, J = | 6 | |
| Dry well storage volume, $S_d = ((PI * D^2) / ((2 * 12)^2)) * (Z_t - Z_b)$ = | 60.9 | cubic feet per dry well |
| Trench storage volume, $S_t = (((PI * D_t^2) / ((2 * 12)^2) * (Z_t - Z_b)) - S_d) * n$= | 38.0 | cubic feet per dry well |
| Total incremental storage volume available, $S_i = S_d + S_t$ | 98.9 | cubic feet per dry well |
| Total storage volume available, $S_{dw} = S_i * J$ | **593** | **cubic feet** |

**Step 5:**
**Calculate the dry well and trench exfiltration rate.**

| | | |
|---|---|---|
| Exfiltration cross-sectional area, $A = (PI * D^2) / ((2 * 12)^2)$ | 19.63 | sq. feet per dry well |
| Incremental exfiltration rate, $O_i = (K * h_L * A) / SF$ | 0.0117 | cubic feet per second per dry well |
| Total dry well and trench exfiltration rate, $O_{dw} = O_i * J$ | **0.070** | **cubic feet per second** |

**Step 6:**
**Calculate the rain garden storage volume.**

| | | |
|---|---|---|
| Surface area of rain garden, A = | 1073.00 | square feet per rain garden |
| Volume of rain garden, $S_i$ = | 1250.00 | cubic feet per rain garden |
| Number of rain gardens, J = | 1 | |
| Total storage volume available, $S_{rg} = S_i * J$ = | **1,250** | **cubic feet** |

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**Step 7:**
**Calculate the rain garden exfiltration rate.**

| | | |
|---|---|---|
| Exfiltration cross-sectional area, $A =$ | 1073.00 | square feet per rain garden |
| Incremental exfiltration rate, $O_i = (K * h_L * A) / SF$ | 0.6381 | cubic feet per second per rain garden |
| Total rain garden exfiltration rate, $O_{rg} = O_i * L$ | **0.638** | **cubic feet per second** |

**Step 8:**
**Calculate the runoff, $Q_u$, based on existing land use using the Rational Method. This value is the allowable outflow rate from the site, $O(t_d)$.**

| | | |
|---|---|---|
| Allowable outflow rate ($Q_u = O(t_d)$) = | 1.932 | cubic feet per second |

**Step 9:**
**Calculate the 100 year rainfall intensity, $i_d$, for various storm durations, $t_d$, using Chen's Method.**

**Step 10:**
**Calculate the runoff, $Q_d$, based on developed conditions for each storm duration, $t_d$, using the Rational Method. These values are the inflow rates to the site for each storm duration, $I(t_d)$.**

$$I(t_d) = C_d * i_d * A_d$$

**Step 11:**
**Calculate the storage rate, $S(t_d)$, for each storm duration, $t_d$.**

$$S(t_d) = I(t_d) - (O_{pp} + O_{dw} + O_{rg} + O(t_d))$$

**Step 12:**
**Calculate the required storage volume, $S_R$, for each storm duration, $t_d$.**

$$S_R = S(t_d) * t_d * 3{,}600$$

**Step 13:**
**Calculate the total available storage volume, $S_A$, for each storm duration, $t_d$.**

$$S_A = S_{pp} + S_{dw} + S_{rg}$$

**Step 14:**
**Calculate the adjusted required storage volume, $S_T$, for each storm duration, $t_d$.**

$$S_T = S_R - S_A$$

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| Storm Duration, $t_d$ (hours) | 100 Year Rainfall Intensity, $i_d$ (inches per hour) | Inflow Rate, $I(t_d)$ (cfs) | Perforated Pipe / Trench Exfiltration Rate, $O_{pp}$ (cfs) | Dry Well / Trench Exfiltration Rate, $O_{dw}$ (cfs) | Rain Garden Exfiltration Rate, $O_{rg}$ (cfs) | Allowable Outflow Rate, $O(t_d)$ (cfs) | Storage Rate, $S(t_d)$ (cfs) | Required Storage Volume, $S_R$ (cubic feet) | Perforated Pipe / Trench Storage Volume, $S_{pp}$ (cubic feet) | Dry Well / Trench Storage Volume, $S_{dw}$ (cubic feet) | Rain Garden Storage Volume, $S_{rg}$ (cubic feet) | Total Available Storage Volume, $S_A$ (cubic feet) | Adjusted Required Storage Volume, $S_T$ (cubic feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.17 | 8.37 | 129.8 | 7.522 | 0.070 | 0.638 | 1.932 | 119.7 | 71,801 | 14,513 | 593 | 1,250 | 16,356 | 55,445 |
| 0.25 | 6.96 | 108.0 | 7.522 | 0.070 | 0.638 | 1.932 | 97.8 | 88,022 | 14,513 | 593 | 1,250 | 16,356 | 71,666 |
| 0.33 | 5.99 | 92.9 | 7.522 | 0.070 | 0.638 | 1.932 | 82.7 | 99,276 | 14,513 | 593 | 1,250 | 16,356 | 82,920 |
| 0.42 | 5.27 | 81.8 | 7.522 | 0.070 | 0.638 | 1.932 | 71.7 | 107,484 | 14,513 | 593 | 1,250 | 16,356 | 91,129 |
| 0.50 | 4.72 | 73.3 | 7.522 | 0.070 | 0.638 | 1.932 | 63.1 | 113,662 | 14,513 | 593 | 1,250 | 16,356 | 97,306 |
| 0.58 | 4.29 | 66.5 | 7.522 | 0.070 | 0.638 | 1.932 | 56.4 | 118,402 | 14,513 | 593 | 1,250 | 16,356 | 102,047 |
| 0.67 | 3.93 | 61.0 | 7.522 | 0.070 | 0.638 | 1.932 | 50.9 | 122,078 | 14,513 | 593 | 1,250 | 16,356 | 105,722 |
| 0.75 | 3.64 | 56.4 | 7.522 | 0.070 | 0.638 | 1.932 | 46.3 | 124,938 | 14,513 | 593 | 1,250 | 16,356 | 108,582 |
| 0.83 | 3.39 | 52.5 | 7.522 | 0.070 | 0.638 | 1.932 | 42.4 | 127,154 | 14,513 | 593 | 1,250 | 16,356 | 110,798 |
| 0.92 | 3.17 | 49.2 | 7.522 | 0.070 | 0.638 | 1.932 | 39.0 | 128,851 | 14,513 | 593 | 1,250 | 16,356 | 112,495 |
| 1.00 | 2.98 | 46.3 | 7.522 | 0.070 | 0.638 | 1.932 | 36.1 | 130,121 | 14,513 | 593 | 1,250 | 16,356 | 113,765 |
| 2.00 | 1.80 | 27.9 | 7.522 | 0.070 | 0.638 | 1.932 | 17.7 | 127,642 | 14,513 | 593 | 1,250 | 16,356 | 111,286 |
| 3.00 | 1.32 | 20.4 | 7.522 | 0.070 | 0.638 | 1.932 | 10.3 | 111,070 | 14,513 | 593 | 1,250 | 16,356 | 94,714 |
| 4.00 | 1.05 | 16.3 | 7.522 | 0.070 | 0.638 | 1.932 | 6.2 | 88,909 | 14,513 | 593 | 1,250 | 16,356 | 72,553 |
| 5.00 | 0.88 | 13.7 | 7.522 | 0.070 | 0.638 | 1.932 | 3.5 | 63,716 | 14,513 | 593 | 1,250 | 16,356 | 47,360 |
| 6.00 | 0.76 | 11.9 | 7.522 | 0.070 | 0.638 | 1.932 | 1.7 | 36,609 | 14,513 | 593 | 1,250 | 16,356 | 20,253 |
| 7.00 | 0.68 | 10.5 | 7.522 | 0.070 | 0.638 | 1.932 | 0.3 | 8,175 | 14,513 | 593 | 1,250 | 16,356 | 0 |
| 8.00 | 0.61 | 9.4 | 7.522 | 0.070 | 0.638 | 1.932 | -0.7 | -21,234 | 14,513 | 593 | 1,250 | 16,356 | 0 |
| 9.00 | 0.55 | 8.6 | 7.522 | 0.070 | 0.638 | 1.932 | -1.6 | -51,394 | 14,513 | 593 | 1,250 | 16,356 | 0 |
| 10.00 | 0.51 | 7.9 | 7.522 | 0.070 | 0.638 | 1.932 | -2.3 | -82,151 | 14,513 | 593 | 1,250 | 16,356 | 0 |

**Step 15:**
**Select the largest required storage volume, $S_T$, calculated in Step 14. This is the volume of storage that is still required.**

| | |
|---|---|
| Required storage volume = | **2.61 acre-feet** |
| | **113,765 cubic feet** |

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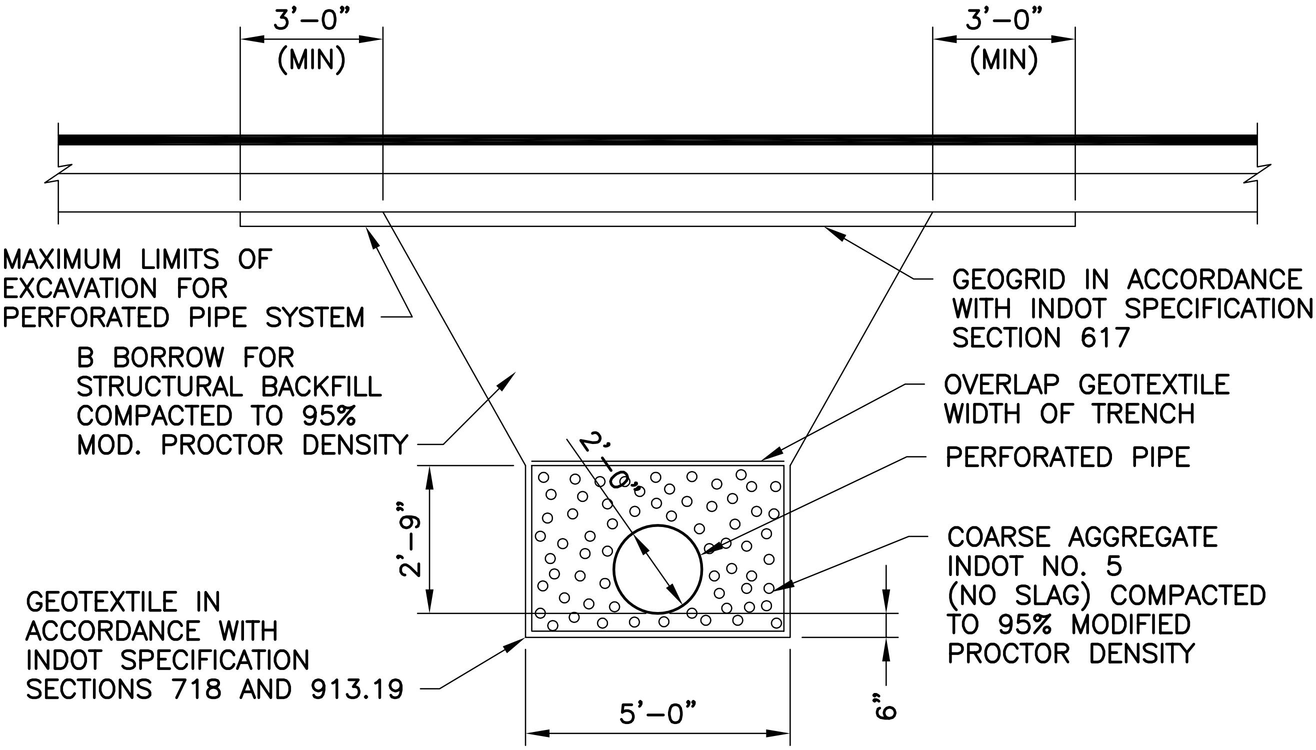


## NOTES:

1. INSTALL GEOGRID OVER ENTIRE PERFORATED PIPE SYSTEM TO A MINIMUM OF 3 FEET BEYOND THE MAXIMUM LIMITS OF EXCAVATION FOR INSTALLATION OF THE SYSTEM.

# PERFORATED PIPE TRENCH DETAIL

| NO. | REVISION | DATE |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

CITY OF GARY, INDIANA
DEPARTMENT OF PUBLIC WORKS
GARY SANITARY DISTRICT
GARY STORM WATER MANAGEMENT DISTRICT

FIGURE 7–3

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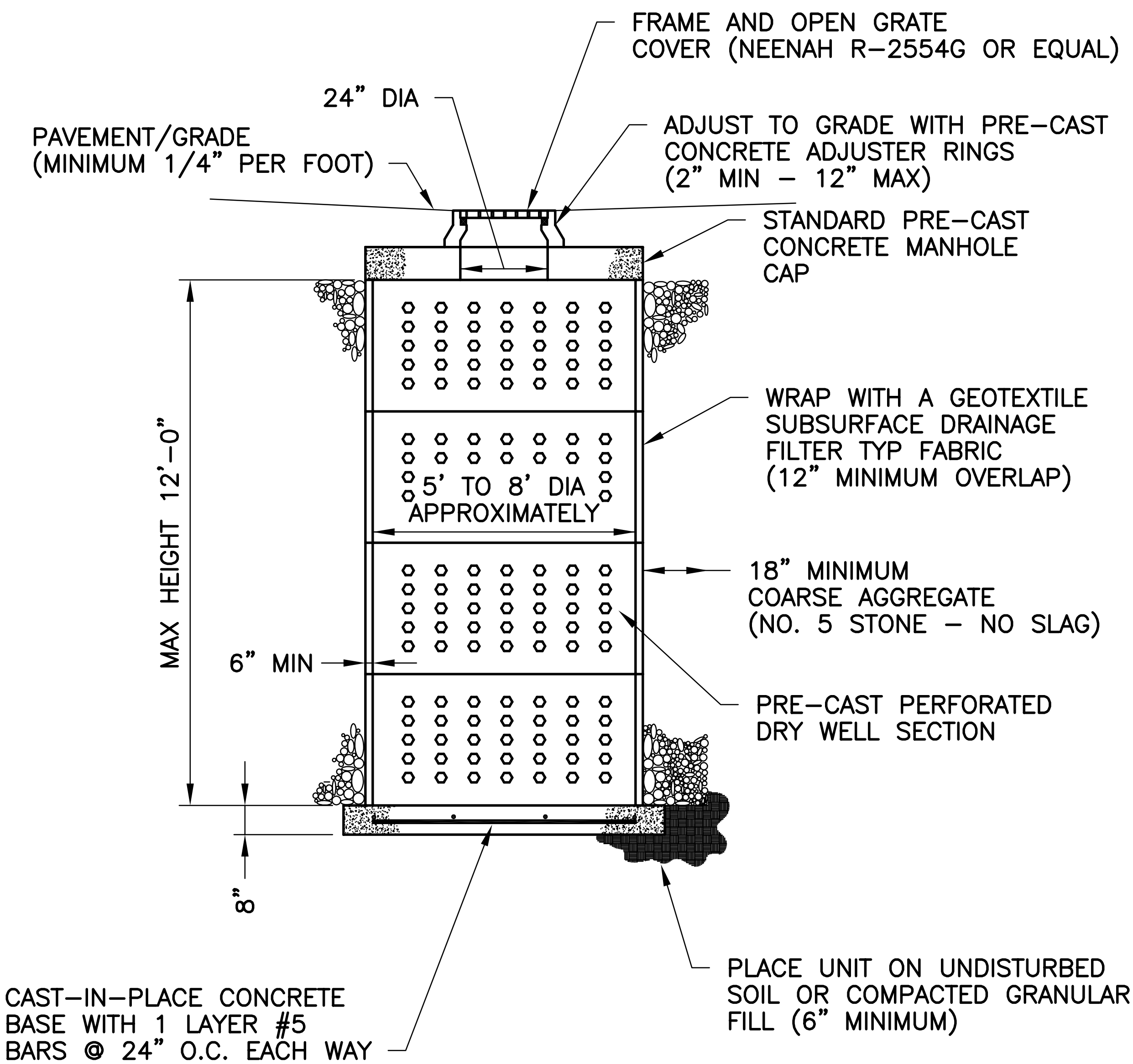


## NOTES:

1. CONTRACTOR TO SURCHARGE AND COMPLETELY FILL DRYWELL WITH WATER AFTER INSTALLATION AND PRIOR TO PLACING PAVEMENT
2. DRY WELL SHALL BE CONSTRUCTED TO MEET ASTM C478 STANDARDS AND AASHTO HS20-44 LOADINGS

# STANDARD PRE-CAST PERFORATED DRY WELL

| NO. | REVISION | DATE |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

CITY OF GARY, INDIANA
DEPARTMENT OF PUBLIC WORKS
GARY SANITARY DISTRICT
GARY STORM WATER MANAGEMENT DISTRICT

FIGURE 7-4

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# CHAPTER 8

## STORM SEWERS

## 8-1 DESIGN

### 8.1.1 Introduction

This chapter focuses on the design elements and basic hydraulic criteria necessary for the proper design of storm sewer systems. It establishes the minimum standards and technical design criteria for all storm sewer systems within the GSWMD service area. Any proposed variance from these design standards must be approved by the GSWMD.

Construction permits shall be obtained from the GSWMD for the design, construction and installation of all storm sewers. All storm sewer facilities shall be designed and installed / constructed in accordance with this Manual, Ten States Standards, and all applicable State and Federal regulations.

### 8.1.2 Capacity

The hydraulic capacity of storm sewers shall be determined using Manning's Equation. Manufacturer's recommended roughness coefficients shall be used when available. Nomograph solutions are acceptable provided they are documented and submitted for approval. Storm sewers shall be designed to convey the peak flow from a 10 year storm for post-developed conditions, as a minimum. Manning's Equation is:

$$V = (1.486 / n) * R^{2/3} * S^{1/2}$$

where:

V = mean velocity of flow, feet per second

R = hydraulic radius, feet

S = slope of the energy grade line, feet per foot

n = Manning's roughness coefficient, dimensionless

Typical roughness coefficient values and maximum flow velocities are provided in Table 8-1.

**Table 8-1. Typical Manning's Roughness Coefficient Values**

| **Material** | **"n"** | **Maximum Velocity (feet per second)** |
|---|---|---|
| Closed Conduits | | |
| Concrete | 0.013 | 15 |
| Vitrified Clay | 0.013 | 15 |
| Brick | 0.015 | 15 |
| Cast Iron | 0.013 | 15 |
| Circular Corrugated Metal Pipe, Annular Corrugations, 2 2/3 x ½ inch | | |
| Unpaved | 0.024 | 7 |
| 25% Paved | 0.021 | 7 |
| 50% Paved | 0.018 | 7 |
| 100% Paved | 0.013 | 7 |
| Concrete Culverts | 0.013 | 15 |
| HDPE / PVC | 0.012 | 10 |
| Open Channels | | |
| Concrete, Trowel Finish | 0.013 | 15 |
| Concrete, Broom or Float Finish | 0.015 | 15 |
| Gunite | 0.018 | 15 |
| Riprap Placed | 0.030 | 10 |
| Riprap Dumped | 0.035 | 10 |
| Gabion | 0.028 | 10 |
| New Earth (Uniform, Sodded, Clay) | 0.025 | 3 – 5 |
| Existing Earth (Fairly Uniform, With Some Weeds) | 0.030 | 3 – 5 |
| Dense Growth of Weeds | 0.040 | 3 – 5 |
| Dense Weeds and Brush | 0.040 | 3 – 5 |
| Swale with Grass | 0.035 | 3 – 5 |

The design of culverts shall conform to the methodology described in the *Hydraulic Design of Highway Culverts* published by the U.S. DOT Federal Highway Administration, September, 1985. Headwater and tailwater depths shall be considered in all culvert designs.

### 8.1.3 Minimum Size

The minimum pipe diameter of all storm sewers, except perforated underdrains and detention spillway restrictors, shall be 12 inches. Perforated underdrains for use in poorly drained and flat drainage areas shall have a minimum diameter of 4 inches. Care must be taken to inhibit migration of fines from surrounding bedding. This can be accomplished with a No. 5 or No. 8 stone envelope around the underdrain, a permeable filter fabric, or a combination of the two.

The minimum diameter for culverts in public right-of-way is 12 inches.

### 8.1.4 Minimum Slope and Velocities

Uniform slopes shall be maintained between inlets, manholes, and inlets to manholes. Final grade shall be set with full consideration of the capacity required, sedimentation problems, and other design parameters. Minimum and maximum allowable slopes shall be those capable of producing velocities of 3 and 15 feet per second, respectively, when the sewer is flowing full. Oversized sewers shall not be approved to justify using decreased slopes.

Thrust protection shall be provided where pipe slopes exceed 15 percent or where conditions warrant added protection externally and internally.

The minimum velocity in culverts shall be great enough to prevent siltation in the structure. The maximum allowable outlet velocity of culverts with earthen channel outlets shall be 6 feet per second. Outlet protection shall be provided for areas where erosion and scour may be an issue.

### 8.1.5 Hydraulic Grade Line

The hydraulic grade line in newly constructed storm sewers shall not exceed the crown of the pipe by more than 5 percent of the diameter of the pipe for the design storm event. If an exception is requested, the hydraulic grade line shall be determined by starting at the downstream end of the proposed drainage system using the maximum water surface elevation experienced for the design period. For these exceptions, design calculations shall be provided where the hydraulic grade line exceeds the crown of the pipe.

### 8.1.6 Headloss in Structures and Appurtenances

The headloss for local losses in structures and appurtenances shall be taken into account in all designs.

### 8.1.7 Changes in Sewer Size

Sewer size changes are only allowed at manholes and junction chamber structures. The energy gradient must be maintained at these changes. An approximate method for achieving this is to place the 0.8 depth point of both sewers at the same elevation. Another method involves matching of pipe crown elevations.

#### *8.1.7.1 Pipes Less Than or Equal to 24 inch Diameter*

When increasing pipe diameter by 6 inches or less, crown elevations at the centerline of the manhole shall match. When increasing pipe diameter by more than 6 inches, the springlines of the pipes at the centerline of the manhole shall match.

#### *8.1.7.2 Pipes Greater Than 27 inch Diameter*

The junction shall first be designed by matching crowns at the centerline of the junction chamber. The energy grade line shall then be evaluated in both the upstream and downstream segments. The grade line shall not increase in the downstream segment. If the energy grade line of the downstream segment lies below the energy grade line of the upstream segment, the downstream sewer may be raised by 2/3 of the difference between the upstream and downstream grade lines.

### 8.1.8 Horizontal Alignment Criteria

#### *8.1.8.1 General*

All storm sewers shall be laid with straight horizontal alignment between manholes. Horizontal alignment, as shown on the contract drawings, shall be within 1 inch of the true line. Any storm sewer found to deviate from the horizontal alignment as described herein shall be removed and re-laid to straight alignment.

Where long radius curves are necessary to conform to street layout, the minimum radius of curvature shall be no less than 100 feet for sewers 42 inches and larger in diameter.

Consideration for allowances for future curb and gutter shall be taken into account when considering storm sewer location. In areas with concrete pavement, consideration shall be given to placing the sewer in a location such that one edge of the pavement to be removed coincides with existing construction joints. This procedure will allow for the sawing and removal of only one side of the pavement.

#### *8.1.8.2 Manholes*

Manholes shall be installed to provide access to continuous underground storm sewers for the purpose of inspection and maintenance. Manholes shall be located within easily accessible, dedicated easements or right-of-way areas of sufficient size to facilitate the required maintenance of these structures. Manholes shall be installed at the end of each sewer line; at all changes in grade, size, materials, or alignment; where two or more sewers converge; and at the point of beginning or at the end of a curve, and at the point of reverse curvature (PC, PT, PRC). The interval between manholes shall not be greater than 300 feet.

Manhole structures shall be either completely outside the pavement or completely inside the pavement. The existence of curbs or proposals for future curb and gutter shall be taken into account when evaluating the benefit of reducing the number of manholes in curved streets.

#### *8.1.8.3 Minimum Horizontal Separation*

Where sewer depth is 10 feet or less, sewer lines and manholes shall be located a minimum of 10 feet horizontally from any part of a building structure or its foundation. For sewer depths greater than 10 feet, this minimum distance shall be 15 feet.

Storm sewers shall be laid at least 10 feet horizontally from any existing or proposed water main when measured outside edge to outside edge. In instances where it is not possible to maintain a 10 feet separation, the GSWMD may allow deviation on a case-by-case basis. This deviation may allow installation of the storm sewer closer to the water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation so the bottom of the water main is at least 18 inches above the top of the storm sewer.

If it is impossible to maintain proper separation as described above, both the water main and storm sewer must be constructed per 327 IAC 3-6-9(b). In all instances when separation cannot be maintained, the GSWMD shall be consulted for guidance and approval.

No storm sewer manhole shall be within 8 feet of a water main when measured from the outside edge of the manhole to the outside edge of the water main.

#### *8.1.8.4 Minimum Distance from Additional Utilities*

All plans shall show the location of both underground and overhead utilities. The location of the utilities shall be derived from the best information available. Each of the utilities shall receive a set of plans on which they may note changes or additions to utility information. The adequacy of the separation of the storm sewer line and other utilities shall be determined by both the appropriate utility company and the design engineer. Any necessary relocations shall be closely coordinated with the respective utility company. Utility company contact information, including telephone numbers, shall be included on the plans of all storm sewer projects.

### 8.1.9 Vertical Alignment Criteria

#### *8.1.9.1 General*

All storm sewers shall be laid with straight vertical alignment between manholes. Allowable deviation from vertical grade shown on the contract drawings shall be no more than 3/8 inch below or above the true grade line. Any storm sewer found to deviate from the vertical alignment as described herein shall be removed and re-laid to straight alignment.

#### *8.1.9.2 Sewer Depths*

Storm sewers shall have a minimum cover of 18 inches as measured from the top of pipe. If the pipe is to be placed under pavement, then the minimum pipe cover shall be 3 feet.

#### *8.1.9.3 Minimum Vertical Separation from Water Lines*

A minimum vertical separation of 18 inches between the outside of a water main and the outside of the storm sewer shall be maintained when measured from outside edge to outside edge. Any crossing shall be arranged such that sewer joints are as far as possible from water main joints. Every effort shall be made to construct the sewer below the water main. Where a water main crosses beneath a sewer, structural support and exfiltration testing shall be provided to ensure the integrity of the water main. If it is impossible to maintain an 18 inch vertical separation as described above, both the water main and sewer must be constructed per 327 IAC 3-6-9(b). In all instances when separation cannot be maintained, the GSWMD shall be consulted for guidance and approval.

#### *8.1.9.4 Sewer Elevations*

All storm sewer elevations shall be referenced to US national datum. When connecting to or extending existing sewer facilities that were constructed using a datum other than USGS, an elevation equation shall be shown on the plans.

The Engineer shall submit a storm sewer design summary spreadsheet showing the routing and sizing calculation results used to determine the storm sewer sizes.

## 8-2 STANDARD SPECIFICATIONS

The following sections provide standard specifications for storm sewer and open drainage culvert materials, installation and construction, and quality control.

### 8.2.1 Gravity Storm Sewer Materials

The following materials are acceptable for gravity storm sewers, except flexible pipe will not be allowed for gravity storm sewers under pavement (defined as back of curb to back of curb):

1. Reinforced Concrete Pipe (RCP) conforming to ASTM C76 or ASTM C655; Classes III, IV, and V in accordance with ASTM C76.
2. Reinforced concrete horizontal elliptical pipe (low head elliptical and arch pipe); elliptical pipe conforming to ASTM C507 and arch pipe conforming to ASTM C506.
3. Precast reinforced concrete box sections conforming to ASTM C1433.
4. Ductile Iron Pipe (DIP) conforming to ANSI A21.51 and AWWA C151. DIP shall be standard cement lined and seal coated with an approved bituminous seal coat in accordance with ANSI A21.4 and AWWA C104.
5. Centrifugally cast fiberglass mortar pipe conforming to ASTM D3262.
6. High Density Polyethylene Pipe (HDPE), 12 inch to 48 inch only; corrugated HDPE conforming to AASHTO M294, Type S and SP; ribbed HDPE conforming to ASTM F894 and smooth wall HDPE conforming to ASTM F714.
7. Polyvinyl Chloride Pipe (PVC), 15 inches or less in diameter, shall conform to the requirements of ASTM D 3034 and a minimum wall thickness equal to SDR 35. For depths of cut over 18 feet, the minimum wall thickness shall be equal to SDR 26. All PVC pipe and fittings, greater than 15

inches in diameter, shall conform to ASTM F679. The PVC material shall conform to ASTM D1784.

8. Spiral Rib Metal Pipe (SRP) conforming to AASHTO M36 and formed from aluminum coated Type 2 sheet conforming to AASHTO M274.

Each length of pipe shall be marked per the requirements of the respective ASTM, AWWA, and / or ANSI standard. The Contractor shall furnish, upon request, certified reports stating that inspection and specified tests have been made and that the results thereof comply with the applicable standards.

### 8.2.2 Open Culvert Facilities

The following materials are acceptable for open culvert drainage structures, including driveway culverts within public right-of-way:

1. Reinforced Concrete Pipe (RCP) conforming to ASTM C76 or ASTM C655; Classes III, IV, and V in accordance with ASTM C76.
2. Reinforced concrete horizontal elliptical pipe (low head elliptical and arch pipe); elliptical pipe conforming to ASTM C507 and arch pipe conforming to ASTM C506.
3. Precast reinforced concrete box sections conforming to ASTM C1433.
4. Ductile Iron Pipe (DIP) conforming to ANSI A21.4 and AWWA C104. The DIP shall be seal coated with bituminous material or cement lined.
5. 14 gauge precoated, galvanized steel conforming to ASTM A760, formed from zinc-coated steel sheet materials conforming to ASTM A885.
6. 14 gauge aluminum coated Type II corrugated steel pipe conforming to ASTM A760.
7. 14 gauge aluminum alloy helical ribbed pipe and 14 gauge corrugated aluminum alloy pipe conforming to ASTM B745 and fabricated from aluminum alloy sheet and plate as specified in ASTM B209.
8. Steel structural plate pipe, pipe arches, and long spans formed from galvanized structural plate in conformance with ASTM B761 and ASTM A796.
9. Corrugated aluminum alloy box culvert formed from aluminum alloy structural plate in conformance with ASTM B790 and ASTM B746.
10. Corrugated galvanized steel box culvert formed from galvanized structural plate in conformance with ASTM A761 and ASTM A796.

All pipes and culverts in open channels or ditches shall have end treatments that consider public safety and control of erosion.

### 8.2.3 Joints and Fittings

#### *8.2.3.1 Ductile Iron Pipe*

Fittings shall be standardized for the type of pipe and joint specified and shall comply with ANSI A21.10, AWWA C110 and AWWA C153. Fittings shall be either mechanical joint or push-on type. Pipe joints shall use O-ring gaskets in accordance with ANSI 21.11 and AWWA C111. The gasket shall be a continuous ring of flexible joint rubber of a composition and texture which is resistant to common ingredients of sewage, industrial wastes, and groundwater; and which will endure permanently under the conditions likely to be imposed by this service.

#### *8.2.3.2 Reinforced Concrete Pipe*

Concrete pipe shall be furnished with a bell or groove on one end of each unit of pipe, and a spigot or tongue on the adjacent end of the adjoining pipe section. All joints shall have a groove on the spigot for placement of a flexible, rubber gasket in conformance with AASHTO M198 or ASTM C443. The gasket shall be a continuous ring that fits snugly into the annular space between the overlapping surfaces of the assembled pipe joint to form a flexible soil-tight seal.

RCP fittings shall be constructed of Type I or Type III Portland cement in accordance with ASTM C150.

#### *8.2.3.3 Reinforced Concrete Box*

Reinforced concrete box joints shall be produced with male and female ends and shall be designed to allow box sections to be placed together in a continuous line. The joint shall be sealed using either a flexible sealant or approved equal to form a soil-tight seal.

Fittings shall be constructed of Type I or Type III Portland cement in accordance with ASTM C150.

### *8.2.3.4 Corrugated Metal Pipe*

External coupling bands conforming to standards set forth in ASTM B745 and ASTM A760 are acceptable for use in construction of corrugated metal pipe joints. All coupling bands shall be fabricated with annular corrugations to lap an equal portion of the adjoining pipe section. The gauge and coating material of the coupling bands shall be consistent with the pipe material. The joint shall be soil-tight. The pipe ends shall be matched at the joint such that the difference in diameter between abutting pipes is no more than ½ inch around the entire pipe circumference.

All corrugated metal pipe couplings shall be wrapped with a strip of nonwoven geotextile around the entire pipe circumference to prevent the intrusion of bedding and backfill materials. The geotextile fabric width shall be 1 foot plus the width of the band to allow for a 6 inch overlap at each band edge. Rubber gaskets may be used in place of geotextile fabric provided that the gaskets are placed on each end corrugation and hugger type bands are used that seat into the second corrugation from the end of the pipe on both pipes at the joint. Bolted connectors are required on the bands such that compression of the rubber gaskets occurs. Rubber gasket diameters shall be per manufacturer's recommendations. CMP fittings shall be constructed of the same material as the corrugated metal pipe.

### *8.2.3.5 High Density Polyethylene*

HDPE pipe joints shall be compression type, gasketed, flexible joints or butt heat fusion joints.

HDPE pipes shall possess a male and female pipe end that allows the construction of overlapping, gasketed pipe joints in conformance with ASTM D3212. For these compression type, gasketed, flexible joints, the gasket inside the machined groove on the pipe spigot shall be compressed radially in the pipe forming a watertight seal. The gasket material shall conform to ASTM F477.

Butt heat fusion joints shall conform to ASTM D3261.

HDPE fittings shall comply with AASHTO M252 and AASHTO M294. Fittings shall be high molecular weight HDPE and meet the requirements of ASTM D3350.

#### *8.2.3.6 Polyvinyl Chloride*

Flexible gasketed joints shall be compression type so that when assembled, the gasket inside the bell will be compressed radially on the pipe spigot to form a watertight seal. The assembly of joints shall be in accordance with the pipe manufacturer's recommendations and ASTM D3212. The gaskets sealing the joint shall be made of rubber of special composition having a texture to assure a watertight and permanent seal. The gasket shall be a continuous ring of flexible joint rubber of a composition and texture which is resistant to common ingredients of sewage, industrial wastes and groundwater; and which will endure permanently under the conditions likely to be imposed by this service. The gasket shall conform to ASTM F477. No solvent welded joints or coupling joints shall be allowed.

Only manufactured fittings made of PVC plastic having a cell classification of 12454-B or 12454-C as defined in ASTM D1784 shall be used.

### 8.2.4 Installation and Construction

Suitable tools and equipment shall be used for the safe and convenient handling and installation of all sanitary sewer. All pipes, gaskets, and fittings shall be thoroughly cleaned prior to installation. No portion of a sanitary sewer pipe, manhole, or force main shall be installed directly onto frozen ground or with frozen backfill material. Bedding and backfill shall be in accordance with Section 1 of this Manual.

All pipe and fittings shall be carefully inspected before being laid, and no cracked, broken or defective pipe or special shall be used in the work. All pipe shall be carefully inserted in the bell in such a manner that there will be no unevenness of any kind along the bottom half of the pipes and so that there is a uniform joint space all around.

The Contractor shall use caution when stringing thermoplastic pipe. Excessive spans in sunlight will cause bowing damage, and said damaged spans will be rejected. The Contractor shall take special precautions when homing PVC pipe not to over-seat past the home-marks.

All field cutting of pipe shall be done in a neat manner as per manufacturer's recommendations. Field cut pipe will only be allowed to be installed at manholes, at prefabricated tees and wyes, and at the connection of new sanitary sewer to existing sanitary sewer.

All pipe that is field cut shall have the homing-marks reestablished, insuring for proper seating depths. Pipes that are field cut shall have the cut ends retapered, by grinding or filing, as close to the original taper provided by the manufacturer as possible. When homing pipe with a spud-bar or other mechanical equipment other than by hand, place a piece of wood between pipe and tool to prevent damage to bell end-section.

The ends of the pipes shall be protected to prevent the entrance of dirt or other foreign substances. Such protection shall be placed at night or whenever pipe laying is stopped for any reason. Suitable plugs designed for use with the pipe material shall be provided and properly secured and used to cap all slants and branches.

### 8.2.5 Quality Control

#### *8.2.5.1 General*

This section describes the minimum requirements and general procedures for the inspection, testing and acceptance of storm sewer systems dedicated to the City of Gary, GSD, and GSWMD.

Inspection of the construction shall occur for the duration of the project. The Owner / Contractor shall execute the Agreement with the GSWMD for such services if the GSWMD does not have staff available to perform such inspections.

Contractor and / or Owner shall provide notice to the GSWMD of the planned commencement of construction 30 days prior to such commencement.

Once the construction starts, the Contractor shall be responsible for informing and / or notifying the assigned inspection representative of the following:

1. daily work schedule, including any changes in schedule;
2. prior notification if work is to be performed on weekends and / or holidays;
3. date tests are to be performed; and
4. date record drawing verification is to be performed.

The GSWMD, upon request of the Contractor and / or Owner, will schedule the Final Inspection.

The Contractor shall furnish all labor, materials, and equipment required for making such tests. All testing required shall be paid for by the Contractor and performed under the observation of the GSWMD or GSWMD's representative. It shall be the Contractor's responsibility to schedule the testing with the GSWMD representative and / or GSWMD. Test results obtained in the absence of the GSWMD will not be accepted.

#### *8.2.5.2 Deflection Testing*

Deflection tests shall be performed on all flexible storm sewer pipe. Deflection testing shall not be required for pipe runs with inlets or catch basins on one end of the pipe run. The test shall be conducted after the final backfill has been in place at least 30 days. The line shall be flushed prior to the deflection tests.

A deflection test report of the completed sewer shall be submitted to the GSWMD within 90 days of completion of construction. The deflection testing report shall include, at a minimum, the following information:

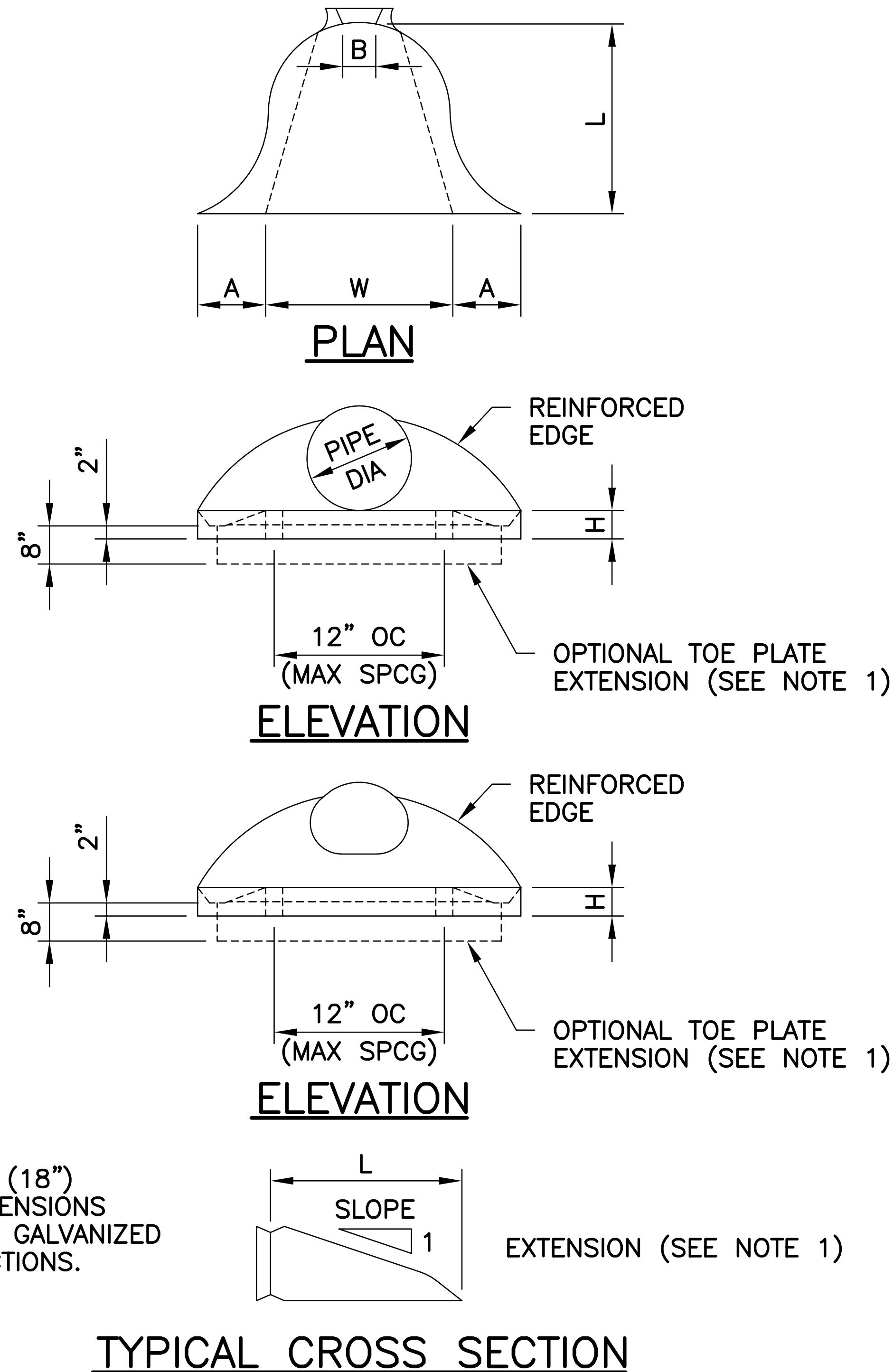
1. identification of the sewer segment (manhole to manhole) tested;
2. length and diameter of the sewer segment tested;
3. complete description of test procedure and equipment used;
4. allowable and actual deflection;
5. test results;
6. name of the inspector / tester and the date(s) and time(s) of all testing performed, including retesting; and
7. description of any repairs made.

Maximum deflection of the pipe shall be limited to 7.5 percent of the vertical internal pipe diameter. All pipe exceeding this deflection shall be considered to have reached the limit of its serviceability and shall be relaid or replaced by the Owner / Contractor.

The cost of all deflection testing shall be borne by the Contractor and shall be accomplished by using a deflectometer, which will produce a continuous record of pipe deflection, or by pulling a mandrel, sphere, or pin-type go / no go device through the pipeline. The diameter of the go / no go device shall be 92.5 percent of the undeflected inside diameter of the flexible pipe. The mandrel shall be pulled through the sewers by one man, by hand, and specifically without the aid of mechanical devices.

## 8-3 STANDARD DETAILS

| Standard Detail Title | Figure Number |
|---|---|
| Culvert Pipe Metal End Section Detail | 8-1 |
| Culvert Pipe Concrete End Section Detail | 8-2 |




NOTE:

1. EIGHTEEN INCH (18") TOE-PLATE EXTENSIONS REQ'D FOR ALL GALVANIZED STEEL END SECTIONS.

# CULVERT PIPE METAL END SECTION DETAIL

| NO. | REVISION | DATE |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

CITY OF GARY, INDIANA
DEPARTMENT OF PUBLIC WORKS
GARY SANITARY DISTRICT
GARY STORM WATER MANAGEMENT DISTRICT

FIGURE
8-1

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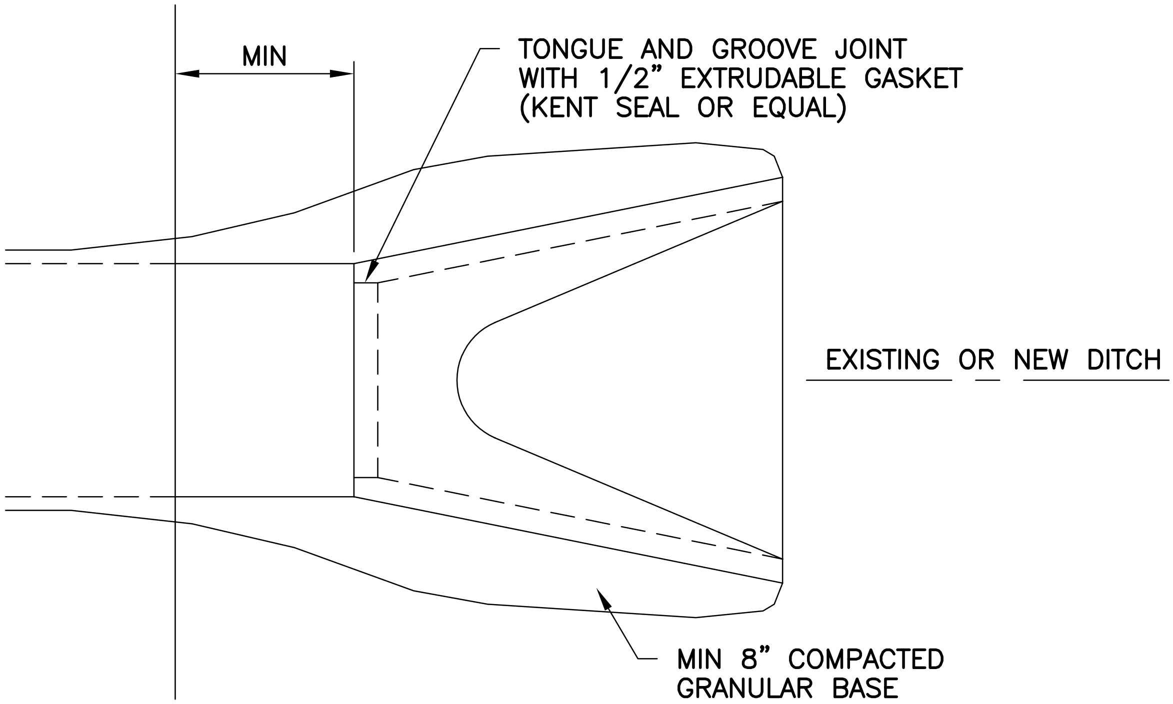


## NOTES:

1. MANUFACTURE OF END SECTION TO BE IN ACCORDANCE WITH APPLICABLE PORTIONS OF ASTM C76.
2. GRADE AREA TO COVER PIPE/END SECTION JOINT.

# CULVERT PIPE CONCRETE END SECTION DETAIL

| NO. | REVISION | DATE |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

CITY OF GARY, INDIANA
DEPARTMENT OF PUBLIC WORKS
GARY SANITARY DISTRICT
GARY STORM WATER MANAGEMENT DISTRICT

FIGURE

8–2

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# CHAPTER 9

## STORM SEWER MANHOLES

### 9-1 STANDARD SPECIFICATIONS

The following sections provide standard specifications for storm sewer manhole materials, installation and construction.

### 9.1.1 Materials

#### *9.1.1.1 Types of Manholes*

Manholes shall be either monolithic (cast-in-place) or precast. If monolithic manholes are to be used, the Contractor shall submit drawings showing all reinforcement, dimensions, connections, and concrete mix for GSWMD approval. All drawings shall be certified by a professional engineer registered in the State of Indiana.

The minimum inside diameter of manholes shall be 48 inches. A minimum access diameter of 22 inches shall be provided for all manholes.

#### *9.1.1.2 Precast Manholes*

Manholes shall be constructed in accordance with ASTM C478. The minimum wall thickness shall be 5 inches for manholes 4 feet in diameter. When the depth of the manhole exceeds 12 feet, the depth in excess of 12 feet shall be reinforced with two cages of reinforcement the same as required for reinforced concrete sewer pipe of same diameter as the riser of the manhole per ASTM C76 for Class III Pipe. The precast tops shall be of the eccentric cone type.

Hoisting lugs or hooks shall be cast in place for handling and setting of the rings. Openings of proper sizes and suitable design shall be cast in place for receiving the sewer and / or drop pipes and connections.

#### *9.1.1.3 Manhole Steps*

Steps will be required in all manholes. The steps shall have a minimum design live load of 300 ft-lbs. The steps shall begin 2 feet above the manhole bench and continue on 12 to 16 inch centers up the entire length of the manhole barrel and cone. The top step shall be positioned no greater than 36 inches from the finished surface grade. The steps shall be 12 inches wide and 1 inch square.

Manhole steps shall be polypropylene, polypropylene coated steel reinforcing, or an approved non-corrosive, fiberglass material. The copolymer polypropylene shall meet the requirements of ASTM D4101, reinforced with deformed 3.8 inch minimum diameter reinforcing steel conforming to the requirements of ASTM A615, Grade 60. Cast iron steps are not acceptable.

#### *9.1.1.4 Manhole Bases*

Manhole bases shall be cast-in-place monolithic concrete or precast concrete. The base shall be 6 inches minimum thickness for 48 inch diameter structures. The floor of the manhole outside the channels shall be smooth and slope toward the channel not less than 1 inch per foot.

For all manholes with equal diameter influent and effluent pipes, a minimum 0.10 foot drop between the inverts of the influent and effluent pipes shall be maintained to offset losses experienced at manhole structures.

The flow channel through a manhole shall be made to conform in shape and slope to that of connecting sewers. The channel walls shall be shaped or formed to the springline of the outlet sewer.

The bottom invert of all pipe entering a manhole shall be at least 3 inches above the top of the base slab so that the finished sewer channel may be installed and shaped. The installation of the final sewer channel may be done at the point of fabrication of the precast base or cast-in-place.

#### *9.1.1.5 Adjusting Rings*

Final adjustments in elevation of the casting frame and grate for precast manholes shall only be accomplished by the use of precast concrete adjusting rings conforming to ASTM C478. Rings shall be of a minimal nominal thickness of 2 inches and not more than 12 inches total of adjusting rings shall be allowed for adjustment of the frame and grate to required elevation. ½ inch of preformed flexible sealant or approved equal shall be placed in the center of the concrete rings along with any necessary grout. The sealant shall also be placed at the cone / slab interface and below the manhole casting.

#### *9.1.1.6 Frames and Covers*

Gray cast iron frames and covers shall conform to the requirements of ASTM A48 for Gray Cast Iron. Ductile cast iron frames and covers shall conform to the requirements of ASTM A536 for Ductile Cast Iron. Storm sewer manhole covers shall have 2 inch high imprinted letters indicating "STORM SEWER". The following manhole frames and covers shall be acceptable:

1. 24 inch Manhole Frame and Cover
   a. Frame and Solid Lid: Neenah R-1772 or East Jordan 1022, heavy duty
2. 24 inch Manhole Frame and Grate
   a. Frame and Gate: Neenah R-2502 or East Jordan 1022 M1

### 9.1.2 Installation and Construction

Precast base sections shall be placed on a well-graded granular bedding course conforming to the requirements for sewer bedding, but not less than 4 inches in thickness and extended to the limits of the excavation. The bedding course shall be firmly tamped and made smooth and level to assure uniform contact and support of the precast element.

Cast-in-place bases shall be at least 6 inches in thickness and shall extend at least 6 inches radially outside of the outside dimensions of the manhole section.

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# CHAPTER 10

# POST-CONSTRUCTION STORM WATER MANAGEMENT

## 10-1 INTRODUCTION

Water quality controls address the impacts of the amount and type of pollutants discharged to receiving streams via storm water. To reduce the impact of discharges on receiving streams, storm water management facilities should be designed to improve the quality of discharge water by providing treatment within a structure. Additionally, a number of structural and non-structural facilities and management practices have been developed to remove or reduce pollutants in storm water runoff and in discharges from storm water management facilities. These methods are termed Best Management Practices (BMPs).

The EPA has prepared a National Menu of Best Management Practices for Storm Water Phase II (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/menu.cfm). The storm water technology fact sheets that comprise the EPA menu contain descriptions, applicability, design criteria, and operation and maintenance procedures for several structural and non-structural BMPs that are acceptable for storm water management within the City of Gary.

## 10-2 STRUCTURAL BEST MANAGEMENT PRACTICES

Structural controls treat storm water runoff in some type of collection facility and involve one or more of the following principles: infiltration, filtration, detention / retention, and evaporation / transpiration.

Infiltration practices are used to capture a volume of runoff and allow it to naturally percolate through surface soils into the groundwater. These practices, a) reduce the total volume of runoff discharge from the site which decreases peak flows in storm sewers and downstream waters, b) filtrate sediment and other pollutants by various chemical, physical, and biological processes as runoff water moves through the bottom of the infiltration structure and into the underlying soil, and c) facilitate groundwater reserve recharge.

Filtration practices filter particulate matter from runoff. Filtration systems provide only limited flood storage and thus are most often implemented in conjunction with other types of quantity control practices.

Detention / retention facilities provide pollutant removal by delaying the runoff from entering receiving waters and allowing particulate matter to settle. Retention facilities are offline systems that contain and then release runoff through withdrawal or evaporation. Runoff management ponds can be designed to control the peak discharge rates, thereby preventing excessive flooding and downstream erosion. Pond systems designed primarily as volume control structures provide minimal pollutant removal capabilities. However, pond systems can be designed with extended detention, sediment forebays, planted wetlands basins, and permanent pools which improve water quality performance significantly by creating conditions within the basin for physical and biological treatment of pollutants in storm water runoff.

Evaporation / transpiration reduces the quantity of runoff released to waterbodies. In warm, dry climates, evaporation from runoff detention areas such as rooftops, streets, basins, and ponds can be an important mechanism for runoff management.

### 10.2.1 Ponds

#### *10.2.1.1 Dry Extended Detention Ponds*

Dry extended detention ponds (i.e., dry ponds, extended detention basins, detention ponds, extended detention ponds) are basins whose outlets have been designed to detain the storm water runoff from a water quality design storm for some minimum time (e.g., 24 hours) to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool; however, they are often designed with small pools at the inlet and outlet of the basin. These facilities can also be used to provide flood control by including additional flood detention storage. Dry extended detention ponds are designed to temporarily detain runoff during storm events.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix E in the EPA BMP handout titled, *Post-Construction Storm Water Management in New Development & Redevelopment: Dry Extended Detention Pond*.

#### *10.2.1.2 Wet Detention Ponds*

Wet ponds (i.e., storm water ponds, retention ponds, wet extended detention ponds) are constructed basins that have a permanent pool of water throughout the year (or at least throughout the wet season). Ponds treat incoming storm water runoff by settling and algal uptake. The primary removal mechanism is settling as storm water runoff resides in this pool, and pollutant uptake, particularly of nutrients, also occurs through biological activity in the pond. Wet ponds are among the most cost-effective and widely used storm water practices.

While there are several different versions of the wet pond design, the most common modification is the extended detention wet pond, where storage is provided above the permanent pool in order to detain storm water runoff in order to provide settling. The primary functions of a wet pond are to detain storm water and facilitate pollutant removal through settling and biological uptake.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix E in the EPA BMP handouts titled, *Post-Construction Storm Water Management in New Development & Redevelopment: Dry Extended Detention Pond* and *Storm Water Technology Fact Sheet: Wet Detention Ponds*.

### 10.2.2 Infiltration Practices

#### *10.2.2.1 Infiltration Basin*

An infiltration basin is a shallow impoundment which is designed to infiltrate storm water into the ground water. This practice is believed to have a high pollutant removal efficiency and can also help recharge the groundwater, thus restoring low flows to stream systems. Infiltration basins can be challenging to apply on many sites; however, because of soils requirements. Infiltration basins are designed to collect storm water from impervious areas and provide pollutant removal benefits through detention and filtration.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix F in the EPA BMP handout titled, *Post-Construction Storm Water Management in New Development & Redevelopment: Infiltration Basin*.

##### *10.2.2.2 Infiltration Drainfields*

Infiltration drainfields are specially designed to promote storm water infiltration into subsoils. These drainfields help to control runoff and prevent the contamination of local watersheds. The system is usually composed of a pretreatment structure, a manifold system, and a drainfield. Runoff is first diverted into a storm sewer system that passes through a pretreatment structure such as an oil and grit separator. The oil and grit chamber effectively removes coarse sediment, oils, and grease from the runoff. The storm water runoff then continues through a manifold system into the infiltration drainfield. The manifold system consists of a perforated pipe which distributes the runoff evenly through the infiltration drainfield. The runoff then percolates through an underlying aggregate sand filter and filter fabric into the subsoils.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix F in the EPA BMP handout titled, *Storm Water Technology Fact Sheet: Infiltration Drainfields*.

##### *10.2.2.3 Infiltration Trench*

An infiltration trench (i.e., infiltration galley) is a rock-filled trench lined with filter fabric with no outlet that receives storm water runoff. Storm water runoff passes through some combination of pretreatment measures, such as a swale and detention basin, and into the trench. There, runoff is stored in the void space between the stones and infiltrates through the bottom and into the soil matrix. The primary pollutant removal mechanism of this practice is filtering through the soil.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix F in the EPA BMP handouts titled, *Post-Construction Storm Water Management in New Development & Redevelopment: Infiltration Trench* and *Storm Water Technology Fact Sheet: Infiltration Trench*.

##### *10.2.2.4 Porous Pavement*

Porous pavement is a permeable pavement surface with an underlying stone reservoir to temporarily store surface runoff before it infiltrates into the subsoil. This porous surface replaces traditional pavement allowing parking lot storm water to infiltrate directly and receive water quality treatment. There are a few porous pavement options, including porous asphalt, pervious concrete, and grass pavers. Porous asphalt and pervious concrete appear to be the same as traditional pavement from the surface, but are manufactured without "fine" materials and incorporate void spaces to allow infiltration. Grass pavers are concrete interlocking blocks or synthetic fibrous gridded systems with open areas designed to allow grass to grow within the void areas. Other alternative paving surfaces can help reduce the runoff from paved areas but do not incorporate the stone trench for temporary storage below the pavement.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix F in the EPA BMP handouts titled, *Post-Construction Storm Water Management in New Development & Redevelopment: Porous Pavement* and *Storm Water Technology Fact Sheet: Porous Pavement*.

### 10.2.3 Filtration Practices

#### *10.2.3.1 Bioretention*

Bioretention areas, often referred to as rain gardens, are landscaping features adapted to provide onsite treatment of storm water runoff. Bioretention areas are commonly located in parking lot islands or within small pockets of residential land uses. Bioretention utilizes soils and both woody and herbaceous plants to remove pollutants from storm water runoff. Runoff is conveyed as sheet flow to the treatment area which consists of a grass buffer strip, sand bed, ponding area, organic or mulch layer, planting soil, and plants. Runoff passes first over or through a sand bed which slows the runoff velocity and distributes it evenly along the length of the ponding area. Water is ponded and gradually infiltrates the bioretention area or is evapotranspired. The bioretention area is graded to divert excess runoff away from itself. Stored water in the bioretention area planting soil exfiltrates over a period of days into the underlying soils.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix G in the EPA BMP handouts titled, *Post-Construction Storm Water Management in New Development & Redevelopment: Bioretention* and *Storm Water Technology Fact Sheet: Bioretention*.

#### *10.2.3.2 Sand and Organic Filters*

A typical sand filter system consists of two or three chambers or basins. The first is the sedimentation chamber which removes floatables and heavy sediments. The second is the filtration chamber, which removes additional pollutants by filtering the runoff through a sand bed. The third is the discharge chamber. The treated filtrate normally is then discharged through an underdrain system either to a storm drainage system or directly to surface waters. Sand filters are able to achieve high removal efficiencies for sediment, biochemical oxygen demand, and fecal coliform bacteria.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix G in the EPA BMP handouts titled, *Post-Construction Storm Water Management in New Development & Redevelopment: Sand and Organic Filters* and *Storm Water Technology Fact Sheet: Sand Filters*.

### 10.2.4 Vegetative Practices

#### *10.2.4.1 Storm Water Wetlands*

Storm water wetlands (i.e., constructed wetlands) are structural practices similar to wet ponds that incorporate wetland plants into the design. As storm water runoff flows through the wetland, pollutant removal is achieved through settling and biological uptake. Wetlands are among the most effective storm water practices in terms of pollutant removal and also offer aesthetic value.

Although natural wetlands can sometimes be used to treat storm water runoff that has been properly pretreated, storm water wetlands are fundamentally different from natural wetland systems. Storm water wetlands are designed specifically for the purpose of treating storm water runoff and typically have less biodiversity than natural wetlands in terms of both plant and animal life. Several design variations of the storm water wetland exist, each design differing in the relative amounts of shallow and deep water, and dry storage above the wetland.

A distinction should be made between using a constructed wetland for storm water management and diverting storm water into a natural wetland. The latter practice is not recommended because altering the hydrology of the existing wetland with additional storm water can degrade the resource and result in plant die-off and the destruction of wildlife habitat. In all circumstances, natural wetlands should be protected from the adverse effects of development, including impacts from increased storm water runoff. This is especially important because natural wetlands provide storm water and flood control benefits on a regional scale.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix H in the EPA BMP handouts titled, *Post-Construction Storm Water Management in New Development & Redevelopment: Storm Water Wetland* and *Storm Water Technology Fact Sheet: Storm Water Wetlands*.

#### *10.2.4.2 Grassed Swales*

The term swale refers to a series of vegetated, open channel management practices designed specifically to treat and attenuate storm water runoff for a specified water quality volume. As storm water runoff flows through these channels, it is treated through filtering by the vegetation in the channel, filtering through a subsoil matrix, and / or infiltration into the underlying soils. Variations of the grassed swale include the grassed channel, dry swale, and wet swale. The specific design features and methods of treatment differ in each of these designs, but all are improvements on the traditional drainage ditch. These designs incorporate modified geometry and other features for use of the swale as a treatment and conveyance practice.

Swales are designed to trap particulate pollutants, promote infiltration, and reduce the flow velocity of storm water runoff. Vegetated swales can serve as part of a storm water drainage system and can replace curbs, gutters, and storm sewer systems.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix H in the EPA BMP handouts titled, *Post-Construction Storm Water Management in New Development & Redevelopment: Grassed Swales* and *Storm Water Technology Fact Sheet: Vegetated Swales*.

#### *10.2.4.3 Grassed Filter Strip*

Grassed filter strips (i.e., vegetated filter strips, filter strips, and grassed filters) are vegetated surfaces that are designed to treat sheet flow from adjacent surfaces. Filter strips function by slowing runoff velocities and filtering out sediment and other pollutants, and by providing some infiltration into underlying soils. Filter strips were originally used as an agricultural treatment practice and have more recently evolved into an urban practice. With proper design and maintenance, filter strips can provide relatively high pollutant removal.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix H in the EPA BMP handout titled, *Post-Construction Storm Water Management in New Development & Redevelopment: Grassed Filter Strip*.

### 10.2.5 Runoff Pretreatment Practices

#### *10.2.5.1 Catch Basin Inserts*

A catch basin (i.e., storm drain inlet, curb inlet) is an inlet to the storm drain system that typically includes a grate or curb inlet and a sump to capture sediment, debris, and associated pollutants. They are also used in CSO watersheds to capture floatables and settle some solids. Catch basins act as pretreatment for other treatment practices by capturing large sediments. The performance of catch basins at removing sediment and other pollutants depends on the design of the catch basin and maintenance procedures to retain the storage available in the sump to capture sediment.

Catch basin efficiency can be improved using inserts, which can be designed to remove oil and grease, trash, debris, and sediment. Some inserts are designed to drop directly into existing catch basins while others may require extensive retrofit construction.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix I in the EPA BMP handout titled, *Post-Construction Storm Water Management in New Development & Redevelopment: Catch Basins / Catch Basin Insert*.

#### *10.2.5.2 In-Line Storage*

In-line storage refers to a number of practices designed to use the storage within the storm drain system to detain flows. While these practices can reduce storm peak flows, they are unable to improve water quality or protect downstream channels. Storage is achieved by placing devices in the storm drain system to restrict the rate of flow. Devices can slow the rate of flow by backing up flow, as in the case of a dam or weir, or through the use of vortex valves, devices that reduce flow rates by creating a helical flow path in the structure.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix I in the EPA BMP handout titled, *Post-Construction Storm Water Management in New Development & Redevelopment: In-Line Storage*.

### *10.2.5.3 Hydrodynamic Separators*

A variety of products for storm water inlets known as swirl separators, or hydrodynamic structures, have been widely applied in recent years. Swirl separators are modifications of the traditional oil-grit separator and include an internal component that creates a swirling motion as storm water flows through a cylindrical chamber. The concept behind these designs is that sediments settle out as storm water moves in this swirling path. Additional compartments or chambers are sometimes present to trap oil and other floatables. There are several different types of proprietary separators, each of which incorporates slightly different design variations, such as off-line application.

Hydrodynamic separators are flow-through structures with a settling or separation unit to remove sediments and other pollutants. These units are most effective where the materials to be removed from runoff are heavy particulates, which can be settled, or floatables, which can be captured.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix I in the EPA BMP handouts titled, *Post-Construction Storm Water Management in New Development & Redevelopment: Manufactured Products for Storm Water Inlets* and *Storm Water Technology Fact Sheet: Hydrodynamic Separators*.

### *10.2.5.4 Water Quality Inlets*

Water quality inlets (i.e., oil / grit separators, oil / water separators) consist of a series of chambers that promote sedimentation of coarse materials and separation of free oil from storm water. Most also contain screens to help retain larger or floating debris and many also include a coalescing unit that helps promote oil / water separation. Water quality inlets typically capture only the first portion of runoff for treatment and are generally used for pretreament before discharging to other BMPs.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix I in the EPA BMP handout titled, *Storm Water Technology Fact Sheet: Water Quality Inlets*.

#### *10.2.5.5 Modular Treatment Systems*

Several modular treatment systems for treating storm water exist. One of the primary modular storm water treatment systems is the StormTreat System™ which consists of a series of sedimentation chambers and constructed wetlands. Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix I in the EPA BMP handout titled, *Storm Water Technology Fact Sheet: Modular Treatment Systems*.

## 10-3 NON-STRUCTURAL BEST MANAGEMENT PRACTICES

Non-structural BMPs address the location and generation of pollutants by controlling runoff volume at the source, rather than at the facility. Non-structural storm water management methods include pollution prevention techniques designed to control pollutants prior to contact with storm water and discharge in storm water runoff, and housekeeping practices such as street sweeping, urban litter control programs, and fertilizer and pesticide control programs. These storm water management methods focus on controlling the build-up of pollutants on the land surface in between storm events to prevent pollutants from entering storm water runoff.

### 10.3.1 On-Lot Treatment

On-lot treatment refers to a series of practices that are designed to treat runoff from individual residential lots. The primary purpose of most on-lot practices is to manage rooftop runoff and, to a lesser extent, driveway and sidewalk runoff. The primary advantage of managing runoff from rooftops is to reduce the effective impervious cover in a watershed.

Although there are a wide variety of on-lot treatment options, they can all be classified into one of three categories: 1) practices that infiltrate rooftop runoff, 2) practices that divert runoff or soil moisture to a pervious area, and 3) practices that store runoff for later use. The best option depends on the goals of a community, the feasibility at a specific site, and the preferences of the homeowner.

The practice most often used to infiltrate rooftop runoff is the dry well. In this design, the storm drain is directed to an underground rock-filled trench that is similar in design to an infiltration trench. French drains or Dutch drains can also be used for this purpose. In these designs, the relatively deep dry well is replaced with a long trench with a perforated pipe within the gravel bed to distribute flow throughout the length of the trench.

Runoff can be diverted to a pervious area or to a treatment area using site grading, or channels and berms. Treatment options can include grassed swales, bioretention, or filter strips. The bioretention design can be simplified for an on-lot application by limiting the pre-treatment filter and in some cases eliminating the underdrain. Alternatively, rooftop runoff can simply be diverted to pervious lawn areas, as opposed to flowing directly to the street and thus to the storm drain system.

Practices that store rooftop runoff, such as cisterns and rain barrels, are the simplest in design of all of the on-lot treatment systems. Some of these practices are available commercially and can be applied in a wide variety of site conditions. Cisterns and rain barrels are particularly valuable in the arid southwest where water is at a premium, rainfall is infrequent, and reuse for irrigation can save homeowners money.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix J in the EPA BMP handout titled, *Post-Construction Storm Water Management in New Development & Redevelopment: On-Lot Treatment*.

### 10.3.2 Buffer Zones

An aquatic buffer is an area along a shoreline, wetland, or stream where development is restricted or prohibited. The primary function of aquatic buffers is to physically protect and separate a stream, lake, or wetland from future disturbance or encroachment. If properly designed, a buffer can provide storm water management and act as a right-of-way during floods, sustaining the integrity of stream ecosystems and habitats. Technically, aquatic buffers are one type of conservation area that function as an integral part of the aquatic ecosystem and can also function as part of an urban forest.

The three types of buffers are water pollution hazard setbacks, vegetated buffers, and engineered buffers. Water pollution hazard setbacks are areas that separate a potential pollution hazard from a waterway. By providing setbacks from these areas in the form of a buffer, the potential for pollution can be reduced. Vegetated buffers are any number of natural areas that exist to divide land uses or provide landscape relief. Engineered buffers are areas specifically designed to treat storm water before it enters into a stream, lake, or wetland. Buffers can be applied to new development by establishing specific preservation areas and sustaining management through easements or community associations.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix J in the EPA BMP handout titled, *Post-Construction Storm Water Management in New Development & Redevelopment: Buffer Zones*.

### 10.3.3 Open Space Design

Open space design, also known as conservation development or cluster development, is a site design technique that concentrates dwelling units in a compact area in one portion of the development site in exchange for providing open space and natural areas elsewhere on the site. The minimum lot sizes, setbacks, and frontage distances for the residential zone are relaxed in order to create the open space at the site. Open space designs have many benefits in comparison to the conventional subdivisions that they replace: they can reduce impervious cover, storm water pollutants, construction costs, grading, and the loss of natural areas.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix J in the EPA BMP handout titled, *Post-Construction Storm Water Management in New Development & Redevelopment: Open Space Design*.

### 10.3.4 Green Parking

Green parking refers to several techniques applied together to reduce the contribution of parking lots to the total impervious cover in a lot. From a storm water perspective, application of green parking techniques in the right combination can dramatically reduce impervious cover and, consequently, the amount of storm water runoff.

Green parking lot techniques include setting maximums for the number of parking lots created, minimizing the dimensions of parking lot spaces, utilizing alternative pavers in overflow parking areas, and using bioretention areas to treat storm water.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix J in the EPA BMP handout titled, *Post-Construction Storm Water Management in New Development & Redevelopment: Green Parking*.

### 10.3.5 Alternative Turnarounds

Alternative turnarounds are designs for end-of-street vehicle turnarounds that replace cul-de-sacs and reduce the amount of impervious cover created in residential neighborhoods. Many cul-de-sacs have a radius of more than 40 feet. From a storm water perspective, cul-de-sacs create a huge bulb of impervious cover, increasing the amount of storm water runoff. For this reason, reducing the size of cul-de-sacs through the use of alternative turnarounds or eliminating them altogether can reduce the amount of impervious cover created at a site.

Numerous alternatives create less impervious cover than the traditional 40 foot cul-de-sac. These alternatives include reducing cul-de-sacs to a 30 foot radius and creating hammerheads, loop roads, and pervious islands in the cul-de-sac center.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix J in the EPA BMP handout titled, *Post-Construction Storm Water Management in New Development & Redevelopment: Alternative Turnarounds*.

### 10.3.6 Alternative Pavers

Alternative pavers are permeable surfaces that can replace asphalt and concrete and can be used for driveways, parking lots, and walkways. Alternative pavers can replace impervious surfaces creating less storm water runoff. The two broad categories of alternative pavers are paving blocks and other surfaces, including gravel, cobbles, wood, mulch, brick, and natural stone.

Paving blocks are concrete or plastic grids with gaps between them. Paving blocks make the surface more rigid and gravel or grass planted inside the holes allows for infiltration. Depending on the use and soil types, a gravel layer can be added underneath to prevent settling and allow further infiltration.

Gravel, cobbles, wood, and mulch also allow varying degrees of infiltration. Brick and natural stone arranged in a loose configuration allow for some infiltration through the gaps. Gravel and cobbles can be used as driveway material, and wood and mulch can be used to provide walking trails.

Additional information regarding this practice, including siting and design considerations and maintenance, is included in Appendix J in the EPA BMP handout titled, *Post-Construction Storm Water Management in New Development & Redevelopment: Alternative Pavers*.

## 10-4 INSPECTION AND MAINTENANCE

### 10.4.1 General

To maintain the effectiveness of post-construction storm water management BMPs, regular inspection and maintenance of control measures is essential. Routine inspection and maintenance is an efficient way to prevent potential nuisance situations (odors, mosquitoes, weeds, etc.), reduce the need for repair maintenance, and reduce the chance of polluting storm water runoff by finding and correcting problems before the next rain.

In addition to maintaining the effectiveness of storm water BMPs and reducing the incidence of pests, proper inspection and maintenance is essential to avoid the health and safety threats inherent in BMP neglect. The failure of structural storm water BMPs can lead to downstream flooding, causing property damage, injury, and even death.

All storm water BMPs should be inspected for continued effectiveness and structural integrity on a regular basis. Generally, all BMPs should be checked after each storm event in addition to these regularly scheduled inspections. Scheduled inspections will vary among BMPs, e.g., storm drain drop inlet protection may require more frequent inspection to ensure proper operation. During each inspection, the inspector should document whether the BMP is performing correctly, any damage to the BMP since the last inspection, and what should be done to repair the BMP if damage has occurred.

Preventive maintenance involves the regular inspection, testing, and replacement or repair of equipment and operational systems. Storm water systems should be inspected to uncover cracks, leaks, and other conditions that could cause breakdowns or failures of storm water mitigation structures and equipment, which, in turn, could result in discharges of chemicals to surface waters either by direct overland flow or through storm drainage systems. A preventive maintenance program can prevent breakdowns and failures through adjustment, repair or replacement of equipment before a major breakdown or failure occurs.

Typically, a preventive maintenance program should include inspections of catch basins, storm water detention areas, and water quality treatment systems. Without adequate maintenance, sediment and debris can quickly clog storm drainage facilities and render them ineffective.

Additional information regarding BMP maintenance is included in Appendix K in the EPA BMP handouts titled, *Post-Construction Storm Water Management in New Development & Redevelopment: BMP Inspection and Maintenance* and *Storm Water Technology Fact Sheet: Preventive Maintenance*.

### 10.4.2 Post-Construction Storm Water Management Plan

In accordance with the Storm Water Management Ordinance (Appendix E of Section 1) and the Post-Construction Storm Water Management Plan Resolution (Appendix F of Section 1), a post-construction storm water management plan must be submitted with all storm water management permit applications. Specific requirements for the storm water management system operations and maintenance plan are provided in Appendix F of Section 1.

Routine inspections, operation, and maintenance of the storm water management system are the responsibility of the owner. Completed inspection, operation, and maintenance documentation must be maintained by the owner, submitted to the GSWMD annually, and produced upon request by the GSWMD. In addition, the GSWMD must be notified of any changes in storm water management system ownership, major repairs, or system failure, in writing within 30 days of occurrence.

A sample maintenance inspection report form is also provided in Appendix F of Section 1. The sample form is generalized and will require adaptation for use with a specific practice and / or site conditions and is subject to the review and approval of the GSWMD.

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CITY OF GARY / GARY SANITARY DISTRICT / GARY STORM WATER MANAGEMENT DISTRICT
Gary, Indiana

***City of Gary Street, Sewer, and City Infrastructure Standards and Specifications Manual***

# APPENDIX A

# EXAMPLE STORM WATER MANAGEMENT PERMIT AND APPROVAL LETTER

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MAYOR CITY OF GARY
Honorable Scott L. King

DEPUTY MAYOR
Geraldine Tousant

BOARD OF DIRECTORS

Silas Wilkerson III, President
Derrick Earls, Vice-President
Ophelia Woodson, Secretary
________________, Member
________________, Member

Charles Peller, P.E., Director

____________________________

____________________________
____________________________
____________________________
____________________________
____________________________

Re: City of Gary Ordinance No. 7309 Storm Water Management Permit Application
Plans and Specifications for ________________________
Storm Water Management Plan
Application No. ________________ Permit No. ________________
Project Address: _________________

Dear ________________________:

The application, drainage plan report, plans, and specifications for the above referenced project have been reviewed and processed in accordance with rules adopted under City of Gary Ordinance No. 7309. Enclosed is the Construction Permit (Permit No. _________), which applies to the construction of the above referenced storm water management system to be located at ________________________.

Plans and specifications were prepared by ________________________, certified by ________________________, and submitted for review and approval to the Gary Storm Water Management District on ________________________. Revised Contract Documents were submitted on ________________________. Greeley and Hansen LLC, authorized representatives of the Gary Storm Water Management District, reviewed the above referenced permit application and have recommended its approval by the District.

3600 W. 3rd Avenue ♦ Gary, IN 46404 ♦ (219) 944-0595 ♦ FAX: (219) 944-0723

Please review the enclosed Construction Permit carefully and become familiar with its terms and conditions. In addition, it is imperative that the consulting architect/engineer (A/E), inspector and construction contractor be fully aware of these terms, conditions, and reporting and testing requirements. You will note that Attachment 1 to the Permit must be obtained and signed at the Gary Storm Water Management District Office located at 3600 West 3rd Avenue, Gary, Indiana, 46406. Attachment 1 must be signed with a Gary Storm Water Management District Representative as a witness.

Any technical / engineering questions concerning this permit may be addressed to myself at (219) 944-0595. Legal questions or questions concerning appeal procedures should be addressed to Attorney James B. Meyer, at (219) 938-0800.

Sincerely,

Charles Peller, P.E., Director
Gary Storm Water Management District

Enclosure: Permit No. ____

cc: Mr. Jay H. Niec, Greeley and Hansen LLC

Application No. _________
Permit No. _________

GARY SANITARY DISTRICT
PERMIT FOR CONSTRUCTION OF
STORM WATER MANAGEMENT SYSTEM
PURSUANT TO CITY OF GARY ORDINANCE NO. 7309

________________, in accordance with City of Gary Ordinance No. 7309 is authorized, only on and after the effective date of this Permit, to construct the storm water management system located at ________________ in Gary, Indiana. The permittee is required to comply with requirements set forth in Parts I and II hereof.

NOTICE OF EFFECTIVE DATE
CONSTRUCTION PROHIBITED UNTIL EFFECTIVE DATE OF PERMIT

Pursuant to the City of Gary Ordinance No. 7309 this Permit shall become effective on ________________. Commencement of construction is prohibited until the effective date of this Permit.

NOTICE OF EXPIRATION DATE

This Permit shall expire at midnight on ________________. In order to receive authorization to begin construction beyond the date of expiration, the permittee shall submit such information and forms as are required by the Gary Storm Water Management District at least sixty (60) days prior to the expiration date of this Permit.

Signed this _________ day of _________,for the Gary Storm Water Management District.

___________________________
Charles Peller, P.E., Director
Gary Storm Water Management District

Application No. _________
Permit No. _________

STORM WATER MANAGEMENT SYSTEM
DESCRIPTION

*For C-permits*
The proposed storm water management system is designed to treat/store/exfiltrate storm water to the maximum extent reasonably possible prior to allowing an overflow to a connection into the existing combined sewer system *or* The proposed storm water management system is designed to treat/store storm water to the maximum extent practicable prior to allowing an overflow to a connection into the existing storm sewer system. It is proposed to install a storm water treatment facility with a retention/detention design return period of ________________ years and a storage volume of ________________ cubic feet. The project drainage area consists of ________________ acres and has an estimated 100-year storm post-construction runoff / flow rate of ________________ cubic feet per second (cfs). The new outfall(s) and/or outlet(s) will be located at ________________________________.

Inspection during construction will be provided by ________________. Sewer maintenance after completion and storm water treatment (when system involves connection to the combined sewer system) will be provided by the Gary Sanitary District and Gary Storm Water Management District. Post-construction inspection and maintenance of the storm water management system will be provided by _______________________.

*For NC-permits*
The proposed storm water management system is designed to treat/store storm water to the maximum extent practicable prior to allowing overflow into a swale, ditch, surface water, open waterway etc. *or* The proposed storm water management system is designed to treat/store storm water to the maximum extent practicable through exfiltration below grade methods. It is proposed to install a storm water treatment facility with a design return period of ________________ years and a storage volume of ________________ cubic feet. The project drainage area consists of ________________ acres and has an estimated 100-year storm post-construction runoff / flow rate of ________________ cubic feet per second (cfs). The new storage/exfiltration system will have an outlet located at ________________________________.

Inspection during construction will be provided by ________________. Post-construction inspection and maintenance of the storm water management system will be provided by _______________________.

CONDITIONS AND LIMITATIONS TO THE AUTHORIZATION FOR
CONSTRUCTION OF STORM WATER MANAGEMENT SYSTEM

During the period beginning on the effective date of this Permit and extending until the expiration date, the permittee is authorized to construct the above described storm water management system. **Such construction shall conform to all provisions of City of Gary Ordinance No. 7309.** A copy of City of Gary Ordinance No. 7309 is attached for reference. The following specific conditions are also made part of this Permit:

Application No. __________
Permit No. __________

PART I

SPECIFIC CONDITIONS AND LIMITATIONS TO THE CONSTRUCTION PERMIT

Unless specific authorization is otherwise provided under this Permit, Permittee shall also comply with the following conditions:

1. All local permits, including zoning, shall be obtained before construction is begun on this project.

2. All storm water drainage facilities and systems, drainage control systems, and erosion and sediment control systems must comply with all applicable requirements and standards of the City of Gary, Gary Sanitary District, and Gary Storm Water Management District's Sanitary, Storm Sewer, and City Infrastructure Standards and Specifications Manual, Indiana Administrative Code, Gary Sanitary District Sewer Use Ordinance, and City of Gary Ordinance No. 7309, pertaining to design, workmanship, materials and construction.

3. All appropriate erosion control measures shall be implemented.

4. Record drawings shall be submitted to the Gary Storm Water Management District.

5. Plans for construction in a floodplain must be submitted to the Department of Natural Resources and approved prior to the start of construction.

6. Plans and specifications for the construction along and across any state highway must be submitted to the State Highway Commission and approved prior to the start of construction.

7. Sump pumps installed to receive and discharge groundwater or other surface storm waters shall be connected to the storm sewer, where possible, or discharged into a designated storm drainage channel; they shall never be connected to a sanitary sewer. Sump pumps installed to receive and discharge floor drain flow or other liquid waste shall be connected to a sanitary or combined sewer. A sump pump shall only be used for one type of water, either the discharge of storm water or the discharge of liquid waste.

8. All down spouts or roof drains shall discharge onto the ground or be connected to the storm sewer. No down spouts or roof drains may be connected to the sanitary sewers or combined sewers.

9. Footing drains shall be connected to storm sewers where possible or designated storm drainage channels. No footing drains or drainage tile may be connected to the sanitary sewers or combined sewers.

10. Basement floor drains shall be connected to sanitary or combined sewers only.

11. The post-construction inspection and maintenance program detailed in the approved Post-Construction Storm Water Management Plan will be conducted throughout the life of the project.

12. The peak runoff rate after development for the 100-year return period shall not exceed the 10-year pre-development peak runoff rate.

*For C-permits*

13. After construction, the Gary Storm Water Management District shall be given advance notice of the start-up of the facilities for maintenance purposes.

*For NC-permits*

13. For exfiltration systems, stormwater BMP's used in conjunction with exfiltration systems shall be designed to provide the maximum amount of stormwater treatment and storage as economically feasible. At a minimum, the storage calculated to store the peak runoff rate after development for the 100-year return period shall be utilized and the release from the exfiltration system shall not exceed the 10-year pre-development peak runoff rate. The combined sewer system shall be protected from storm water discharges at all times.

This Permit shall be considered void if Attachment 1 to this letter is either not signed by the permittee on the space provided affirming that all conditions are expressly agreed to and will be complied with fully, or if it is not witnessed by a Gary Storm Water Management District Representative.

PART II

GENERAL CONDITIONS

1. No significant or material changes in the scope of the plans or construction of this project shall be made unless the following provisions are met:

   a. Request for permit modification is made 60 days in advance of the proposed significant or material changes in the scope of the plans or construction;

   b. Submit a detailed statement of such proposed changes;

   c. Submit revised plans and specifications including a revised application and drainage plan report; and

   d. Obtain a revised construction permit from the Gary Storm Water Management District.

2. The Gary Storm Water Management District may modify, suspend, or revoke this Permit for cause, including, but not limited to the following:

   a. Violation of any term or conditions of this permit;

   b. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts.

3. **Nothing herein shall be construed to guarantee that the proposed storm water management system will meet standards, limitations or requirements of the Gary Storm Water Management District, Gary Sanitary District, City of Gary or any agency of this state or the federal government.**

Application No. __________
Permit No. __________

ATTACHMENT 1

I hereby certify that I have received Construction Permit No. _______________ issued _______________, for _______________, and expressly agree to comply fully with all conditions contained therein.

| | |
|---|---|
| OWNER: | GSWMD WITNESS: |
| ____________________________ | ____________________________ |
| Signature | Signature |
| ____________________________ | ____________________________ |
| Printed | Printed |
| ____________________________ | ____________________________ |
| Position / Title | Dated |
| ____________________________ | |
| Dated | |

# APPENDIX B

# NPDES GENERAL PERMIT RULE 327 IAC 15-5 (RULE 5) REQUIREMENTS

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MAYOR CITY OF GARY
Honorable Scott L. King

DEPUTY MAYOR
Geraldine Tousant

BOARD OF DIRECTORS

Silas Wilkerson III, President
Derrick Earls, Vice-President
Ophelia Woodson, Secretary
________________, Member
________________, Member

Charles Peller, P.E., Director

____________________________

____________________________
____________________________
____________________________
____________________________
____________________________

Re: ____________________________
NPDES General Permit Rule 327 IAC 15-5 (Rule 5) Requirements

Dear ___________:

In accordance with City of Gary Ordinance No. 7309, a storm water management permit is required before construction may begin for all business, commercial and industrial developments, residential subdivisions, planned unit development, and any redevelopment or other new construction of like kind located within the City of Gary. A copy of City of Gary Ordinance No. 7309 and a storm water management permit application may be obtained by contacting Mr. Charles Peller, P.E., Director of the Gary Storm Water Management District (GSWMD) at 219-944-0595.

**In addition to obtaining a storm water management permit from the GSWMD**, 327 IAC 15-5 (Rule 5) requires a general permit from the Indiana Department of Environmental Management (IDEM) for construction activities that result in the disturbance of one (1) or more acres of land. Land-disturbing activity is defined as, “any manmade change of the land surface, including removing vegetative cover that exposes the underlying soil, excavating, filling, transporting, and grading” (327 IAC 15-5-4(20)). A Rule 5 permit is also required if a project results in the disturbance of less than one (1) acre of land but is considered part of a “larger common plan of development or sale” (327 IAC 15-5-2(a)(3)).

The following steps must be followed to ensure compliance with 327 IAC 15-5:

**Step 1:**
**Develop a Construction Plan.**
The Construction Plan must be a sufficient comprehensive construction plan that includes a project site narrative, vicinity map, existing and final project site layouts, grading plan, drainage plan, storm water pollution prevention plan, and post-construction storm water pollution prevention plan. Specific Construction Plan requirements are provided in 327 IAC 15-5-6.5. The *Indiana Stormwater Quality Manual* (formerly *Indiana Handbook for Erosion Control in Developing Areas*) may be used for guidance in developing the Construction Plan. The *Indiana Stormwater Quality Manual* may be obtained by contacting the Indiana Department of Natural Resources, Division of Soil Conservation at (317) 233-3870 or
http://www.state.in.us/dnr/soilcons/publications/stormwatermanual.html.

**Step 2:**
**Submit the Construction Plan to the Lake County Soil and Water Conservation District (SWCD) for review.**
The SWCD has up to 28 days from the date of submittal to review the Construction Plan. If the project site owner has not received notification that the plan is deficient within the 28-day review period, the completed Notice of Intent (NOI) letter may be submitted to the IDEM (Step 4). If notice of a deficient plan is received, the plans must be revised to satisfy the deficiencies and resubmitted to the SWCD, at which time the 28-day review period starts over. Submit Construction Plans to the following address:

Lake County Soil and Water Conservation District
928 South Court Street, Suite C
Crown Point, Indiana 46307-4848

**Step 3:**
**Receive Construction Plan approval from the SWCD.**
Modifications to the Construction Plan may be requested by the reviewing authority before approval is granted.

**Step 4:**
**Submit a Notice of Intent (NOI) letter to IDEM a minimum of 48 hours prior to initiation of land disturbing activities.**
A complete NOI letter submittal must include: a) a proof of publication in a newspaper of general circulation, b) Construction Plan approval verification form from the SWCD (or expiration of the 28-day review period), and c) a $100 general permit filing fee check or money order. A copy of the NOI letter is enclosed and is also available at:
http://www.in.gov/icpr/webfile/formsdiv/47487.pdf

NOI letters must be submitted to the following address:

IDEM-Office of Water Quality
Rule 5 Storm Water Coordinator
100 North Senate Avenue, Room 1255
P.O. Box 6015
Indianapolis, Indiana 46206-6015

**Step 5:**
**Notify the IDEM within 48 hours of actual construction activity.**
The project site owner, or their designated developer, must notify the IDEM's Rule 5 Coordinator at (317) 233-1864 or jdavis@dem.state.in.us and the Lake County SWCD (219-663-0588) within 48 hours of actual construction activity start-up to inform them of the actual project start date.

**Step 6:**
**Begin construction activities.**
Construction activities may not begin prior to Construction Plan approval and submittal of the NOI letter. The project site owner must also notify IDEM and the SWCD of the actual start date within 48 hours of starting land disturbing activities (Step 5). In addition, a GSWMD storm water management permit must be obtained prior to beginning construction activities.

**Step 7:**
**Implement the approved Construction Plan throughout construction.**
The approved Construction Plan must be implemented before, during, and after construction activities occur. The Construction Plan shall be revised, as necessary, to prevent pollutants, including sediment, from leaving the project site. Communicate regularly with the SWCD, especially when significant revisions to the Construction Plan are made.

**Step 8:**
**Submit a Notice of Termination (NOT) request to the SWCD and the IDEM.**
The project site owner shall plan an orderly and timely termination of construction activities, including the implementation of storm water quality measures that are to remain on the project site. Once all land disturbing activities have been completed, the entire site has been stabilized, and all temporary erosion and sediment control measures have been removed, the project site owner must: a) prepare a complete NOT, with all required supporting documentation and submit it to the SWCD, and b) receive verification from the SWCD that the project meets the termination requirements as specified in Rule 5. Once verified by the SWCD, the SWCD will return the NOT form to the project site owner that must then submit the NOT form to IDEM for final approval. A copy of the NOT request form is enclosed and is also available at:
http://www.in.gov/icpr/webfile/formsdiv/51514.pdf

NOT requests must be submitted to the following address:

IDEM-Office of Water Quality
Rule 5 Storm Water Coordinator
100 North Senate Avenue, Room 1255
P.O. Box 6015
Indianapolis, Indiana 46206-6015

**Step 9:**
**Receive NOT approval from the IDEM.**
After a NOT request has been submitted and approved for a project site, maintenance of the remaining storm water quality measures shall be the responsibility of the individual lot owner or occupier of the property.

For further information and specific details of Rule 5 requirements, please contact and / or review the following:

- IDEM-Office of Water Quality
  Mr. Jay Davis, Rule 5 Coordinator
  Phone: (317) 233-1864
  Email: jdavis@dem.state.in.us

- 327 IAC 15-5: Storm Water Run-Off Associated with Construction Activity
- Storm Water General Permit Rule:
  http://www.in.gov/idem/water/npdes/permits/wetwthr/storm/rule5.html

Sincerely,

Charles G. Peller, Jr., P.E., Director
Gary Storm Water Management District

Enclosures:

NPDES General Permit Rule 327 IAC 15-5 (Rule 5) Notice of Intent (NOI)
NPDES General Permit Rule 327 IAC 15-5 (Rule 5) Notice of Termination (NOT)

cc: Honorable Board of Directors
Mr. James B. Meyer, GSWMD Attorney
Greeley and Hansen LLC

Indiana Department of Environmental Management

**Notice of Intent (NOI)**

Storm Water Runoff Associated with Construction Activity

NPDES General Permit Rule 327 IAC 15-5 **(Rule 5)**

Submission of this Notice of Intent letter constitutes notice that the project site owner is applying for coverage under the National Pollutant Discharge Elimination System (NPDES) General Permit Rule for Storm Water Discharges Associated with Construction Activity. Permitted project site owners are required to comply with all terms and conditions of the General Permit Rule 327 IAC 15-5 (Rule 5).

**Check the type of Submittal: ☐ Initial ☐ Amendment, ☐ Renewal ☐ Extension**

**Project Name and Location:**

- Project Name: ______________________________ County: ____________________
- Brief Description of Project Location: ______________________________
- Latitude ____________________ **and** Quarter ____________ Section ____________
- Longitude ____________________ Township__________ __ Range______________
- Does ☐ all or ☐ part of this project lie within the jurisdictional boundaries of a Municipal Separate Storm Sewer System (MS4) as defined in 327 IAC 15-13? ☐ Yes ☐ No If yes, please name the MS4(s):

  ______________________________________________________________

**Project Site Owner and Project Contact Information:**

- Company Name (If Applicable): ______________________________

  Project Site Owner's Name (An Individual): ____________________ Title/Position: ______________

  Address: ______________________________

  City: ______________ State: ______________ Zip: ______________

  Phone: __________ FAX: __________ E-Mail Address (If Available): ____________________
- Ownership Status (check one): Governmental Agency: ☐ Federal ☐ State ☐Local

  Non-Governmental: ☐ Public ☐ Private ☐ Other (Explain): ______________________________
- Contact Person: ____________________ Affiliation with Project Site Owner: ______________

  Address (if different from above): ______________________________

  City: ______________ State: ______________ Zip: ______________

  Phone: __________ FAX: __________ E-Mail Address (If Available): ____________________

**Project Description:**

☐Residential-Single Family ☐Residential-Multi-Family ☐Commercial ☐Industrial ☐Other____________________

**Discharge Information:**

- Name of Receiving Water:______________________________

  (If applicable, name of municipal operator of storm sewer. Please note that even if a retention pond is present on the property, the name of the nearest possible receiving water is required).

**Project Acreage:**

- Total Acreage: _______ Acres Proposed Acreage to be Disturbed: _______ Acres
- Total Impervious Surface Area (Estimated for Completed Project): ______________ Square Feet

**Timetable (Maximum of 5 Years):**

- Start Date: ______________ and Estimated End Date for all Land Disturbing Activity: ______________

***(Continued on Reverse Side)***

**Construction Plan Certification:**

By signing this Notice of Intent letter, I certify the following:

A. The storm water quality measures included in the Construction Plan comply with the requirements of 327 IAC 15-5-6.5, 327 IAC 15-5-7, and 327 IAC 15-5-7.5;

B. the storm water pollution prevention plan complies with all applicable federal, state, and local storm water requirements;

C. the measures required by section 7 and 7.5 of this rule will be implemented in accordance with the storm water pollution prevention plan;

D. if the projected land disturbance is One (1) acre or more, the applicable Soil and Water Conservation District or other entity designated by the Department, has been sent a copy of the Construction Plan for review;

E. storm water quality measures beyond those specified in the storm water pollution prevention plan will be implemented during the life of the permit if necessary to comply with 327 IAC 15-5-7; and

F. implementation of storm water quality measures will be inspected by trained individuals.

**In addition to this form, I have enclosed the Following:**

☐ Verification by the reviewing agency of acceptance of the Construction Plan.

☐ Proof of publication in a newspaper of general circulation in the affected area that notified the public that a construction activity is to commence, including all required elements contained in 327 IAC 15-5-5 (9).

☐ $100 check or money order payable to the Indiana Department of Environmental Management. If the project lies solely within the permitted jurisdiction of an MS4 and is regulated by the MS4 under 327 IAC 15-13 – a fee is not required with submittal of this Notice of Intent.

A permit issued under 327 IAC 15-5 is granted by the commissioner for a period of five (5) years from the date coverage commences. Once the five (5) year permit term duration is reached, a general permit issued under this rule will be considered expired, and, as necessary for construction activity continuation, a new Notice of Intent letter would need to be submitted ninety (90) days prior to the termination of coverage.

**Project Site Owner Responsibility Statement:**

By signing this Notice of Intent letter, I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information or violating the provisions of 327 IAC 15-5, including the possibility of fine and imprisonment for knowing violations.

Printed Name of Project Owner________________________________________________________

Signature of Project Owner ____________________________________ Date: __________________

**This Notice of Intent must be signed by an individual meeting the signatory requirements in 327 IAC 15-4-3(g)**

**Mail this form to**: **Indiana Department of Environmental Management**
**Office of Water Quality, Storm Water (Rule 5) Desk**
**100 North Senate Avenue, P.O. Box 6015**
**Indianapolis, IN 46206-6015**

**327 IAC 15-5-6 (a) also requires a copy of the completed Notice of Intent letter be submitted to the local Soil and Water Conservation District or other entity designated by the Department, where the land disturbing activity is to occur.**

Questions regarding the development of the Construction Plan and/or field implementation of 327 IAC 15-5 may be directed to your local Soil and Water Conservation District office or the Department of Natural Resources at 317-233-3870. Questions regarding the Notice of Intent may be directed to the Rule 5 contact person at 317/233-1864 or 800/451-6027 ext 31864.

# RULE 5 –

**Notice of Termination (NOT)**
Storm Water Runoff Associated with Construction Activity
NPDES General Permit Rule 327 IAC 15-5 (Rule 5)

State Form 51514 (R / 1-04)

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

**For questions regarding this form, contact:**
IDEM – Rule 5 Coordinator
100 North Senate Avenue, Rm 1255
P.O. Box 6015
Indianapolis, IN 46206-6015
Phone: (317) 233-1864 or
(800) 451-6027, ext. 31864 (within Indiana)
Web Access:
http://www.in.gov/idem/water/npdes/permits/wetwthr/storm/rule5.html

**NOTE:**

- This Notice of Termination must be signed by an individual meeting the signatory requirements in 327 IAC 15-4-3(g).
- Please submit the completed Notice of Termination form to the SWCD, DNR-DSC, or other Entity Designated by the Department as the reviewing agency. The request for termination will be reviewed for concurrence and either returned to the Project Site Owner or forwarded to the IDEM.

Submission of this Notice of Termination letter constitutes notice to the Commissioner that the project site owner is applying for Termination of Coverage under the National Pollutant Discharge Elimination System (NPDES) General Permit Rule for Storm Water Discharges Associated with Construction Activity.

**Project Name and Location:**

Permit Number: ________________

Project Name: ________________________________ County: ____________________

Company Name (If Applicable): ________________________________________

Project Site Owner's Name (An Individual): ________________________________

Address: ________________________________________________

City: ________________ State: ____________ Zip: ____________

Phone: __________ FAX: __________ E-Mail Address (If Available): ________________

## This Notice of Termination is Being Submitted for the Following:

***Select one of the three Options that apply to Permit Termination by checking the appropriate box, complete all information associated with that option, and complete the "Project Site Owner Responsibility Statement".***

**Option # 1**

☐ **Certification for Change of Ownership:**

*(Does not Apply to the Sale of Individual lots within the Permitted Acreage; only the Sale of the Entire Project Site as Originally Permitted)*

By Signing this Notice of Termination, I Certify the Following:

A. The project was sold; I am no longer the project site owner as was designated in my Notice of Intent. The new owner of the project site is:

Company Name (If Applicable): ________________________________________

Project Site Owner's Name (An Individual): ________________________________

Address: ________________________________________________

City: ________________ State: ____________ Zip: ____________

Phone: __________ FAX: __________ E-Mail Address (If Available): ________________

B. I have notified the new Project Site Owner of his/her responsibilities to comply with 327 IAC 15-5 and the requirements associated with the rule including filing a new Notice of Intent.

**Option # 2**

☐ **Certification for Termination of Construction Activities:**

By Signing this Notice of Termination, I Certify the Following:

A. All land disturbing activities, including construction on all building lots have been completed and the entire site has been stabilized;
B. No future land disturbing activities will occur on this project site;
C. all temporary erosion and sediment control measures have been removed; and
D. a copy of this notice has been sent to the appropriate SWCD or other designated entity.

**Option # 3**

☐ **Notice of Termination to Obtain Early Release from Compliance with 327 IAC 15-5**

**By Signing this Notice of Termination, I Certify the Following:**

A. The remaining, undeveloped acreage does not exceed five (5) acres, with contiguous areas not to exceed one (1) acre.
B. A map of the project site, clearly identifying all remaining undeveloped lots, is attached to this letter. The map must be accompanied by a list of names and addresses of individual lot owners or individual lot operators of all undeveloped lots.
C. All public and common improvements, including infrastructure, have been completed and permanently stabilized and have been transferred to the appropriate local entity.
D. The remaining acreage does not pose a significant threat to the integrity of the infrastructure, adjacent properties, or water quality.
E. All permanent storm water quality measures have been implemented and are operational.

**Upon Written Notification of the Department the Project Site Owner Certifies that he/she will Notify:**

A. All current individual lot owners and all subsequent individual lot owners of the remaining undeveloped acreage and acreage with construction activity that they are responsible for complying with section 7.5 of 327 IAC 15-5 *(the remaining individual lot owners do not need to submit a Notice of Intent letter or Notice of Termination letter)*; and
B. the individual lot owners of the requirements to install and maintain appropriate measures to prevent sediment from leaving the individual building lot and maintain all erosion and sediment control measures that are to remain on-site as part of the construction plan.

**Project Site Owner Responsibility Statement:**

By signing this Notice of Termination letter, I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Printed Name of Project Site Owner: ____________________________________________

Signature of Project Site Owner: ______________________________ Date: ____________

**This Notice of Termination must be signed by an individual meeting the signatory requirements in 327 IAC 15-4-3(g).**

**Please submit the completed Notice of Termination form to the SWCD, DNR-DSC, or other Entity Designated by the Department as the reviewing agency. The request for termination will be reviewed for concurrence and either returned to the Project Site Owner or forwarded to the IDEM.**

## For Agency Use Only

☐ **Accepted: The site referenced above has been inspected and it has been determined that the request to terminate this project is compliant with the requirements of 327 IAC 15-5-8. This form will be forwarded to the IDEM for final approval. Upon written notification by the IDEM, the Project Site Owner's termination for coverage under 327 IAC 15-5 shall be considered approved.**

☐ **Denied: The site referenced above has been inspected and it has been determined that the request to terminate this project is NOT compliant with the requirements of 327 IAC 15-5-8. Continue to implement the Stormwater Pollution Prevention Plan and take appropriate measures to minimize the discharge of pollutants.**

| | | | |
|---|---|---|---|
| ____________ | ____________ | ____________ | ______ |
| **Signature** | **Printed Name** | **Agency** | **Date** |

*City of Gary Street, Sewer, and City Infrastructure Standards and Specifications Manual*

# APPENDIX C

# U.S. EPA UNDERGROUND INJECTION CONTROL PROGRAM

# CLASS V WELL REQUIREMENTS

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MAYOR CITY OF GARY
Honorable Scott L. King

DEPUTY MAYOR
Geraldine Tousant

BOARD OF DIRECTORS

Silas Wilkerson III, President
Derrick Earls, Vice-President
Ophelia Woodson, Secretary
________________, Member
________________, Member

Charles Peller, P.E., Director

____________________________

____________________________
____________________________
____________________________
____________________________
____________________________

Re: ____________________________
U.S. EPA Underground Injection Control Program Class V Well Requirements
(40 CFR Part 144)

Dear ___________:

In accordance with City of Gary Ordinance No. 7309, a storm water management permit is required before construction may begin for all business, commercial and industrial developments, residential subdivisions, planned unit development, and any redevelopment or other new construction of like kind located within the City of Gary. A copy of City of Gary Ordinance No. 7309 and a storm water management permit application may be obtained by contacting Mr. Charles Peller, P.E., Director of the Gary Storm Water Management District (GSWMD) at 219-944-0595.

**In addition to obtaining a storm water management permit from the GSWMD**, 40 CFR Part 144 (Underground Injection Control Program) requires that basic inventory and assessment information be submitted to U.S. EPA, Region 5 for all Class V wells. Class V wells are defined as, “shallow wells used to place a variety of fluids directly below the land surface”, and include, “drainage wells used to drain surface fluids, primarily storm runoff, into a subsurface formation” (40 CFR Part 144.80, Subpart 3, and Part 144.81, Subpart 4). An individual Underground Injection Control (UIC) permit may be required if the injection activity may cause a violation of any primary drinking water regulation in an underground source of drinking water (USDW) or otherwise adversely affect the health of persons. The completion of a Class V Well Pre-Closure Notification Form is also required for Class V Wells that are to be placed out of service.

For further information and specific details of UIC program requirements, please contact and / or review the following:

- U.S. EPA, Region 5
  UIC Branch (WU-16J)
  ATTN: Mr. Charles T. Elly, Branch Chief
  77 W. Jackson Boulevard
  Chicago, Illinois 60604-3590
  Phone: (312) 353-5089
  Fax: (312) 886-4235
  Email: elly.charles@epa.gov

- 40 CFR Part 144: Underground Injection Control Program
- Region 5 Underground Injection Control Program:
  http://www.epa.gov/region5/water/uic/
- Underground Injection Control Program:
  http://www.epa.gov/safewater/uic/.html

The following steps must be followed to ensure compliance with 40 CFR Part 144:

**Step 1:**
**Submit the Underground Discharge System (Class V) Inventory Sheet to the U.S. EPA, Region 5, UIC Branch for review prior to construction.**
A complete inventory sheet must include: a) facility name and location, b) name and address of legal contact, c) ownership of property, d) nature and type of injection well(s), and e) operating status of injection well(s). A copy of the inventory sheet is enclosed and is also available at: http://www.epa.gov/region5/water/uic/forms/cl5invfm.pdf.

Inventory sheets must be submitted to the following address:

U.S. EPA, Region 5
UIC Branch (WU-16J)
ATTN: Ms. Lisa Perenchio, Direct Implementation Section Chief
77 West Jackson Boulevard
Chicago, Illinois 60604-3590
Phone: (312) 886-6593
Fax: (312) 886-4235
Email: perenchio.lisa@epa.gov

**Step 2:**
**Receive approval from the U.S. EPA.**
The EPA will do one of three things. The EPA may rule authorize the well(s), i.e., construction may begin as long as the injection activity does not endanger USDWs. The EPA may request additional information prior to making a determination on the well(s). This additional

information will be used for review to determine if the well(s) may endanger USDWs. Finally, the EPA may require that a permit be obtained. The permit will include specific conditions that must be met to ensure the subsurface discharge does not endanger USDWs and may include monitoring, reporting, and / or implementing "best management practices".

**Step 3:**
**Begin construction activities.**
Construction activities may not begin prior to receiving approval from the U.S. EPA, Region 5. The drainage well must be constructed and operated in a manner that does not endanger USDWs. In addition, a GSWMD storm water management permit must be obtained prior to beginning construction activities.

**Step 4:**
**Submit the Class V Well Pre-Closure Notification Form to the U.S. EPA, Region 5, UIC Branch for review prior to well closure.**
A well that is no longer being used must be closed in a manner that prevents movement of contaminated fluids into USDWs, which may cause a violation of national drinking water standards or adversely affect public health. The well must be permanently plugged or closed such that USDWs are protected. In addition, any soil, gravel, sludge, liquids, or other materials removed from or adjacent to your well must be managed or disposed of according to all Federal, State, and local regulations and requirements.

A complete pre-closure notification form must be submitted at least 30 days prior to well closure and must include: a) facility name and location, b) name and address of legal contact, c) ownership of property, d) type of injection well(s), and e) type of injection well(s) closure. A copy of the pre-closure notification form is enclosed and is also available at:
http://www.epa.gov/region5/water/uic/forms/pre_close_form.pdf.

Pre-closure notification forms must be submitted to Ms. Lisa Perenchio at the address listed above.

**Step 5:**
**Receive closure approval from the U.S. EPA, Region 5 and close the well(s).**
The U.S. EPA, Region 5 will approve the well closure or may request additional information be submitted to ensure that the well closure will be conducted in a manner that will protect USDWs.

Sincerely,

Charles G. Peller, Jr., P.E., Director
Gary Storm Water Management District

Enclosures:

Underground Discharge System (Class V) Inventory Sheet
Class V Well Pre-Closure Notification Form

cc: Honorable Board of Directors
Mr. James B. Meyer, GSWMD Attorney
Greeley and Hansen LLC

FOR SAMPLE USE ONLY – COMPARABLE FORMAT ACCEPTABLE

# UNDERGROUND DISCHARGE SYSTEM (CLASS V) INVENTORY SHEET

(see instructions on back)

1. Name of facility: ____________________

   Address of facility: ____________________

   City/Town: ____________________ State: __________ Zip Code: __________

   County: ____________________ Location: ____________________

   ____________________

   Contact Person: ____________________ Phone Number: ____________________

2. Name of Owner or Operator: ____________________

   Address of Owner or Operator: ____________________

   City/Town: ____________________ State: __________ Zip Code: __________

---

3. Type & number of system(s): _____Drywell(s) _____Septic System(s) _____Other(describe): ____________________
   Attach a schematic of the system. Attach a map or sketch of the location of the system at the facility.

4. Source of discharge into system: ____________________

   ____________________

   ____________________

5. Fluids discharged: ____________________

   ____________________

   ____________________

6. Treatment before discharge: ____________________

   ____________________

   ____________________

7. Status of underground discharge system: ☐ Existing ☐ Unused/Abandoned ☐ Under Construction ☐ Proposed

   Approved/Permitted by: ____________________ Date constructed: ____________________

CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (Ref. 40 CFR 144.32).

Signature: ____________________ Date: ____________________

Name (printed): ____________________

Official Title: ____________________

**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**
**REGION 5**

## UNDERGROUND DISCHARGE SYSTEM (CLASS V ) INVENTORY SHEET INSTRUCTIONS

Complete one sheet for each different kind of underground discharge or drainage system (Class V well) at your facility or location. For example, several storm water drainage wells of a similar construction can all go on one sheet. Another example could be a business with a single septic system (septic tank with drainfield) that accepts fluids from a paint shop sink in one area, their vehicle maintenance garage floor drains in another area and also serves the employee kitchenette and washroom: this can all go on one form.

The numbers below correspond to the numbers on the front of the sheet.

1. Supply the name and street address of the facility where the Class V well(s) is located. Please be sure to include the County name. If available, provide the Latitude/Longitude of the discharge system. If there is no street address for the discharge system(s), provide a description of the location and show the location on a map. Include the name and phone number of a person to contact if there are any questions regarding the underground discharge system(s) and/or the wastewaters discharged at the facility.

2. Provide the name and mailing address of the owner of the facility or if the facility is operated by lease, the operator of the facility.

3. Provide the number of underground discharge systems at the facility (or location) for the type of system that is described on this sheet. Please use a separate sheet for each different type of system present. If the type of system is "Other", please describe (e.g., french drain, leachfield, improved sinkhole, cesspool, etc.).

   Provide a sketch, diagram or blueprints of the construction of the system including the depth below the ground surface that the fluids are released into the soil, sediment or formation. Also provide a map or sketch of the layout of the pluming or drainage system, including all the connections, and if applicable, indicate each fluid source connection (i.e., floor drains, shop sink, process tank discharge, restrooms, etc.) and any pre-treatment, etc.

4. Describe the kind of business practice that generates the fluids being discharged into the underground system (e.g., body shop, drycleaner, carwash, print shop, restaurant, etc.), and/or if more appropriate, the source of the fluids (e.g., employee & customer restrooms, parking lot drainage, etc.). If available, include the Standard Industrial Classification (SIC) Codes for this facility.

5. List the kinds of fluids that can enter the underground system (e.g., storm water run-off, sanitary waste, solvents, biodegradable soap wash & rinse water, snowmelt from trucks, photo developing fluids, ink, paint & thinner, non-contact cooling water, etc.). Please be as specific as you can about the kinds of fluids or products that can be drained into the system. Generally, good sources for this information are the Material Safety Data Sheets (MSDS) (copies of MSDS could be attached instead of listing all the products). If available, also attach a copy of any chemical analysis for the fluids discharged.

6. Describe the kinds of treatment (if any) that the fluids go through before disposal. Examples of treatment are: grease trap, package plant, oil/water separator, catch basin, metal recovery unit, sand filter, grit cleanser, etc.

7. Select the status of the underground discharge system and include the date the system was constructed. If the status is “Existing” but it is not being used, is unusable, will not be used, or is temporarily abandoned, mark the box for “Unused/Abandoned”. If state or local government approval was given for construction of the system, or a permit was issued for the system, please provide the name of the approving authority. Provide an estimated date of construction if the actual date is unknown.

The person signing the submittal should read the certification statement before signing and dating the sheet.

If you have any questions about whether or not you may have an EPA regulated system, or about how to complete this sheet, please call (312) 886-1492. You may also try our website at www.epa.gov/r5water/uic/uic.htm for information.

Please send completed sheets to: U.S. EPA Region 5
Underground Injection Control Branch
ATTN: Lisa Perenchio (WU-16J)
77 W. Jackson Blvd.
Chicago, IL 60604

8/02

Type or print all information. See reverse for instructions.

Form Approved 12/99
OMB Control No.2040-0214

**CLASS V WELL PRE-CLOSURE NOTIFICATION FORM**

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF GROUND WATER AND DRINKING WATER

1. Name of facility:______________________________

Address of facility:______________________________

______________________________

City/Town:__________________ State:________ Zip Code:__________

County:__________________ Location:__________________

2. Name of Owner/Operator:______________________________

Address of Owner/Operator:______________________________

______________________________

City/Town:__________________ State:________ Zip Code:__________

Legal contact:__________________ Phone number:__________________

3. Type of well(s):__________________ Number of well(s):__________
4. Well construction (check all that apply):

- ☐ Drywell
- ☐ Improved sinkhole
- ☐ Septic tank
- ☐ Drainfield/leachfield
- ☐ Cesspool
- ☐ Other__________________

5. Type of discharge:______________________________

______________________________

6. Average flow (gallons/day):__________ 7. Year of well construction:__________
8. Type of well closure (check all that apply):

- ☐ Sample fluids/sediments
- ☐ Appropriate disposal of remaining fluids/sediments
- ☐ Remove well & any contaminated soil
- ☐ Other (Describe):______________________________
- ☐ Clean out well
- ☐ Install permanent plug
- ☐ Conversion to other well type

9. Proposed date of well closure:______________________________

10. Name of preparer:__________________ Date:__________________

PAPERWORK REDUCTION ACT NOTICE

The public reporting and recordkeeping burden for this collection of information is estimated to average 1.5 hours per respondent. Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, or disclose or provide information to or for a Federal agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purposes of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to a collection of information; search data sources; complete and review the collection of information; and transmit or otherwise disclose the information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Regulatory Information Division, U.S. Environmental Protection Agency (2137), 401 M St., S.W., Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

**INSTRUCTIONS**

You must complete this form to notify the U.S. EPA that you intend to close a Underground Injection Control (UIC) Class V well at your facility. You may complete one form for more than one of the same type of Class V well at each facility. For example, if you will be closing two drywells that are of similar construction at your facility, you may use one form.

The numbers below correspond to the numbers on the form.

1. Supply the name and street address of the facility where the Class V well(s) is located. Include the City/Town, State (U.S. Postal Service abbreviation) and Zip Code. If there is no street address for the Class V well, provide the route number or locate the well(s) on a map. If available, for the "Location" provide the Latitude/Longitude of the well or the legal description of the facility.

2. Provide the name and mailing address of the owner of the facility or if the facility is operated by lease, the operator of the facility. Include the name and phone number of the legal contact for any questions regarding the information provided.

3. Indicate the type of Class V well that you intend to close. For example, motor vehicle waste disposal well or cesspool). Provide the number of wells of this well type at your location that will be closed.

4. Mark an “x” in the appropriate box to indicate the type of well construction. Mark all that apply to your situation. For example, for a septic tank that drains into a drywell, mark both the “septic tank” and “drywell” boxes. Please provide a generalized sketch or schematic of the well construction if available.

5. List or describe the types of fluids that enter the Class V well. If available, attach a copy of the chemical analysis results and/or the Material Safety Data Sheets for the fluids that enter the well.

6. Estimate the average daily flow into the well in gallons per day.

7. Provide the year that the Class V well was constructed. If unknown, provide the length of time that your business has been at this location and using this well.

8. Mark an “x” in the appropriate box(s) to indicate briefly how the well closure is expected to proceed. Mark all that apply to your situation. For example, all boxes except the “Remove well & any contaminated soil” and “Other” would be marked if: the connection of an automotive service bay drain leading to a septic tank and drainfield will be closed, but the septic system will continue to be used for washroom waste disposal only, and the fluids and sludge throughout the system will be removed for proper disposal, the system cleaned, a cement plug placed in the service bay drain and the pipe leading to the washroom connection, and the septic tank/drainfield remains open for septic use only. In this example, the motor vehicle waste disposal well is being converted to another well type (a large capacity septic system).

9. Self explanatory.

10. Self explanatory.

The purpose of this form is to serve as the means for the Class V well owner or operator’s notice to the UIC Director of their intent to close the well in accordance with Title 40 of the Code of Federal Regulations (40 CFR) Section 144.12 (a). According to 40 CFR §144.86, you must notify the UIC Program Director at least 30 days prior to well closure of you intent to close and abandon your well. Upon receipt of this form, if the Director determines that more specific information is required to be submitted to ensure that the well closure will be conducted in a manner that will protect underground sources of drinking water (as defined in 40 CFR §144.3), the Director can require the owner/operator to prepare, submit and comply with a closure plan acceptable to, and approved by the Director.

Please be advised that this form is intended to satisfy federal UIC requirements regarding pre-closure notification only. Other state, tribal or local requirements may also apply.

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# APPENDIX D

# STORM DISTRIBUTIONS

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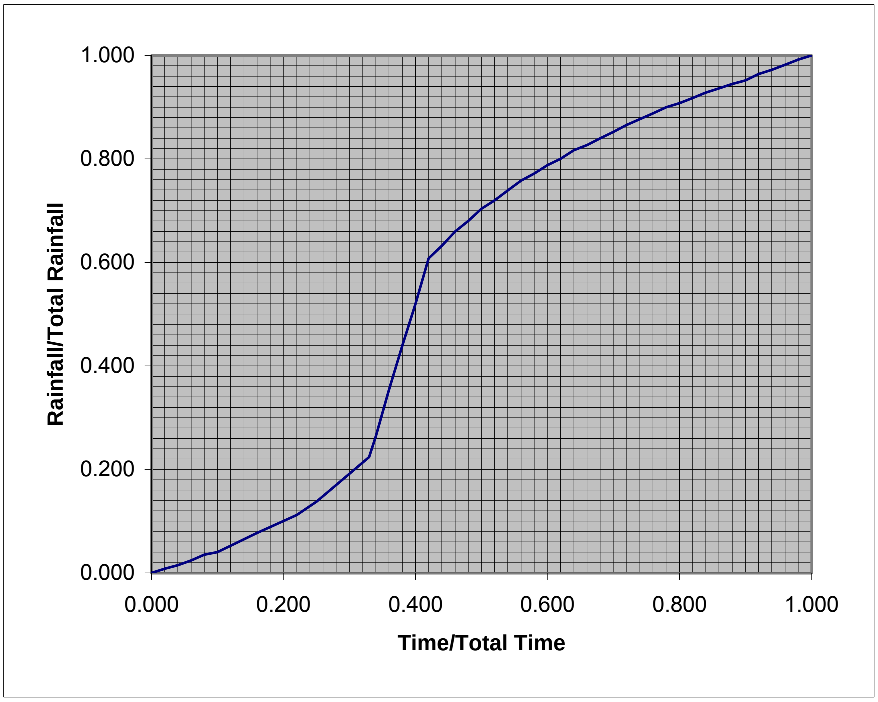
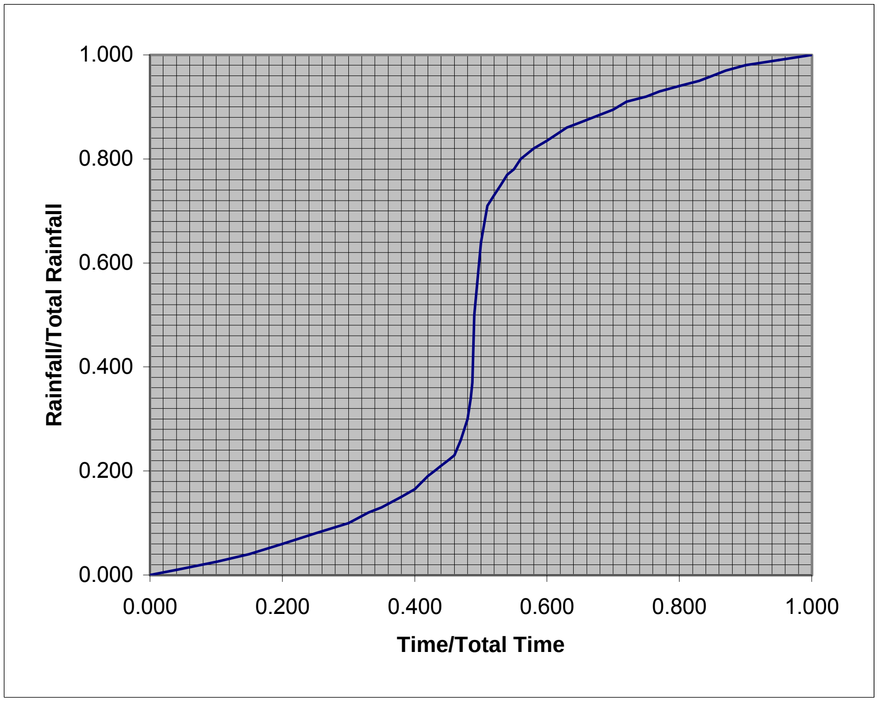
## Soil Conservation Service Type B Storm Distribution




| Time/Total Time | Rainfall/Total Rainfall | Time/Total Time | Rainfall/Total Rainfall |
|---|---|---|---|
| 0.000 | 0.000 | 0.580 | 0.772 |
| 0.020 | 0.008 | 0.600 | 0.788 |
| 0.040 | 0.015 | 0.620 | 0.800 |
| 0.060 | 0.024 | 0.640 | 0.817 |
| 0.080 | 0.035 | 0.660 | 0.827 |
| 0.100 | 0.040 | 0.680 | 0.840 |
| 0.160 | 0.077 | 0.700 | 0.852 |
| 0.200 | 0.100 | 0.720 | 0.866 |
| 0.220 | 0.112 | 0.740 | 0.877 |
| 0.250 | 0.138 | 0.760 | 0.888 |
| 0.330 | 0.224 | 0.780 | 0.900 |
| 0.340 | 0.264 | 0.800 | 0.908 |
| 0.360 | 0.354 | 0.820 | 0.918 |
| 0.380 | 0.440 | 0.840 | 0.928 |
| 0.400 | 0.520 | 0.860 | 0.936 |
| 0.420 | 0.608 | 0.880 | 0.945 |
| 0.440 | 0.632 | 0.900 | 0.952 |
| 0.460 | 0.660 | 0.920 | 0.964 |
| 0.480 | 0.680 | 0.940 | 0.972 |
| 0.500 | 0.704 | 0.960 | 0.982 |
| 0.520 | 0.720 | 0.980 | 0.992 |
| 0.540 | 0.739 | 1.000 | 1.000 |

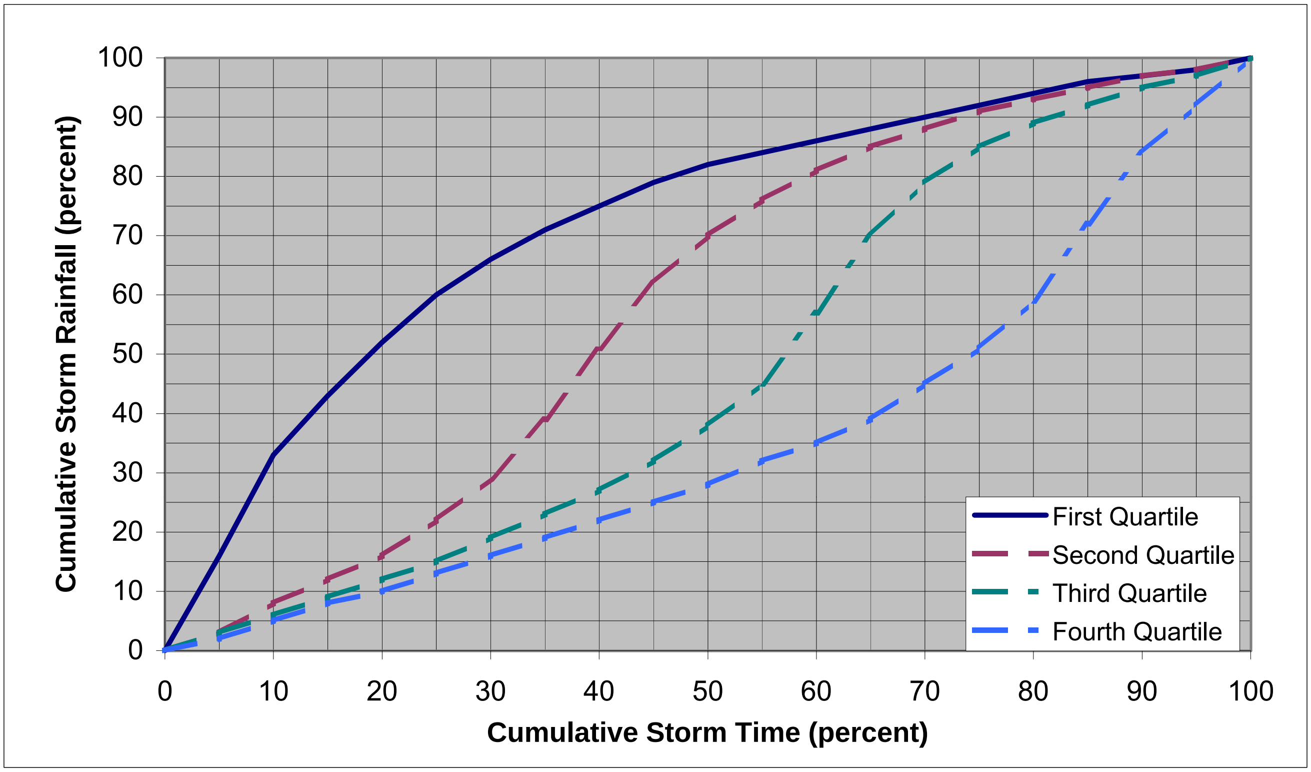
## Soil Conservation Service Type II Storm Distribution




| Time/Total Time | Rainfall/Total Rainfall | Time/Total Time | Rainfall/Total Rainfall |
|---|---|---|---|
| 0.000 | 0.000 | 0.520 | 0.730 |
| 0.040 | 0.010 | 0.530 | 0.750 |
| 0.100 | 0.025 | 0.540 | 0.770 |
| 0.150 | 0.040 | 0.550 | 0.780 |
| 0.200 | 0.060 | 0.560 | 0.800 |
| 0.250 | 0.080 | 0.570 | 0.810 |
| 0.300 | 0.100 | 0.580 | 0.820 |
| 0.330 | 0.120 | 0.600 | 0.835 |
| 0.350 | 0.130 | 0.630 | 0.860 |
| 0.380 | 0.150 | 0.650 | 0.870 |
| 0.400 | 0.165 | 0.670 | 0.880 |
| 0.420 | 0.190 | 0.700 | 0.895 |
| 0.430 | 0.200 | 0.720 | 0.910 |
| 0.440 | 0.210 | 0.750 | 0.920 |
| 0.450 | 0.220 | 0.770 | 0.930 |
| 0.460 | 0.230 | 0.800 | 0.940 |
| 0.470 | 0.260 | 0.830 | 0.950 |
| 0.480 | 0.300 | 0.850 | 0.960 |
| 0.485 | 0.340 | 0.870 | 0.970 |
| 0.487 | 0.370 | 0.900 | 0.980 |
| 0.490 | 0.500 | 0.950 | 0.990 |
| 0.500 | 0.640 | 1.000 | 1.000 |

## Median Time Distributions of Heavy Storm Rainfall at a Point

Cumulative storm rainfall (percent) for given storm type

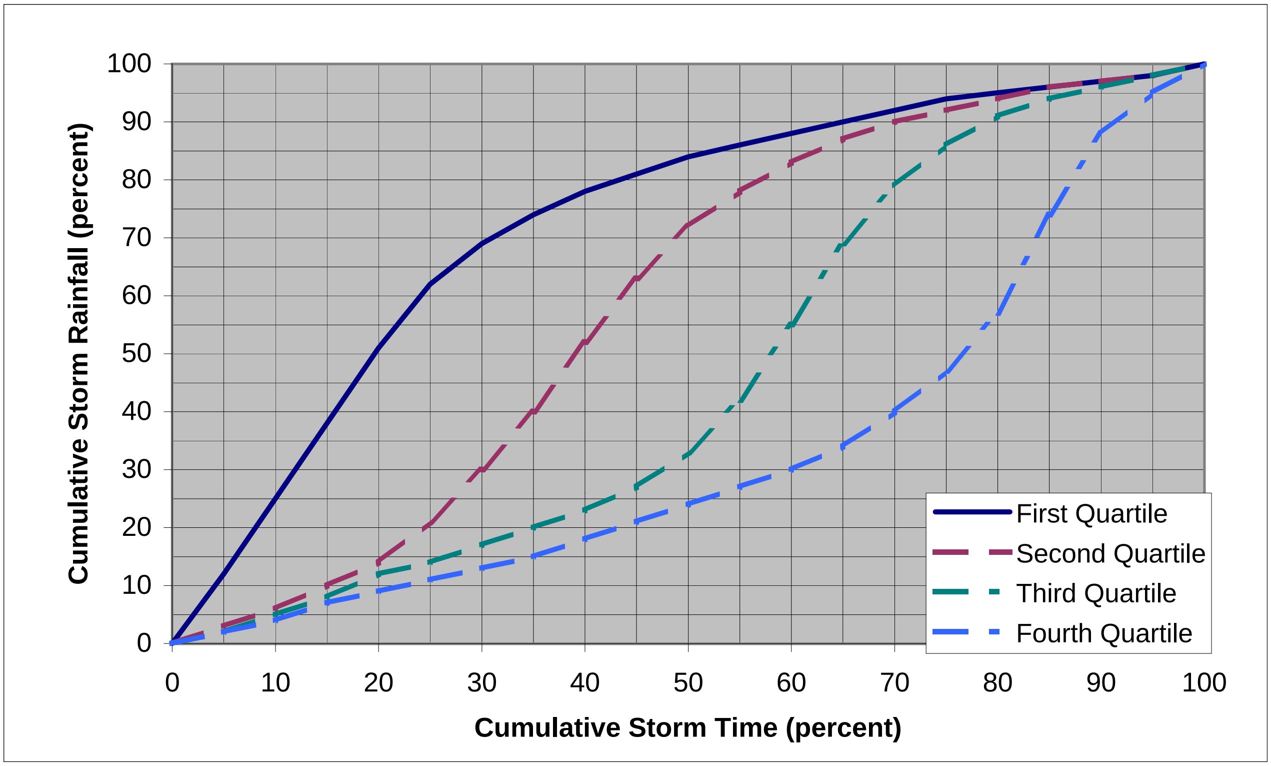



| Cumulative Storm Time (percent) | First quartile | Second quartile | Third quartile | Fourth quartile |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 5 | 16 | 3 | 3 | 2 |
| 10 | 33 | 8 | 6 | 5 |
| 15 | 43 | 12 | 9 | 8 |
| 20 | 52 | 16 | 12 | 10 |
| 25 | 60 | 22 | 15 | 13 |
| 30 | 66 | 29 | 19 | 16 |
| 35 | 71 | 39 | 23 | 19 |
| 40 | 75 | 51 | 27 | 22 |
| 45 | 79 | 62 | 32 | 25 |
| 50 | 82 | 70 | 38 | 28 |
| 55 | 84 | 76 | 45 | 32 |
| 60 | 86 | 81 | 57 | 35 |
| 65 | 88 | 85 | 70 | 39 |
| 70 | 90 | 88 | 79 | 45 |
| 75 | 92 | 91 | 85 | 51 |
| 80 | 94 | 93 | 89 | 59 |
| 85 | 96 | 95 | 92 | 72 |
| 90 | 97 | 97 | 95 | 84 |
| 95 | 98 | 98 | 97 | 92 |
| 100 | 100 | 100 | 100 | 100 |

From NOAA "Bulletin 71, Rainfall Frquency Atlas of the Midwest", 1992

## Median Time Distributions of Heavy Storm Rainfall on Areas of 10 to 50 Square Miles

Cumulative storm rainfall (percent) for given storm type

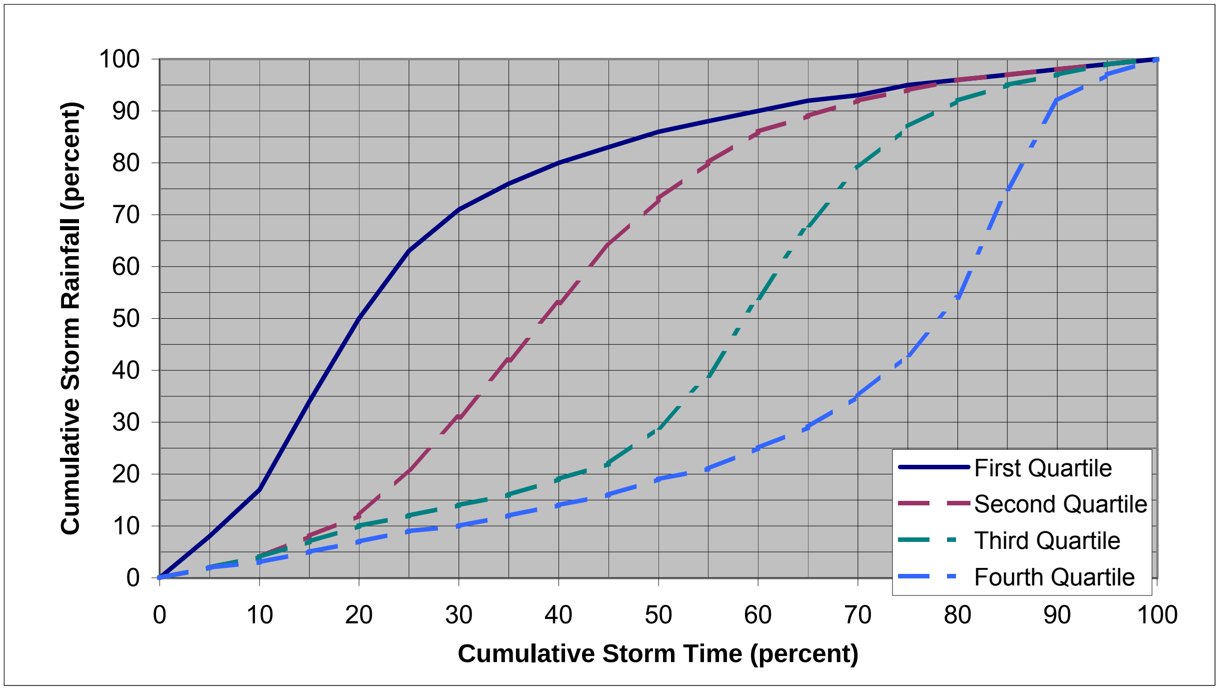



| Cumulative Storm Time (percent | First quartile | Second quartile | Third quartile | Fourth quartile |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 5 | 12 | 3 | 2 | 2 |
| 10 | 25 | 6 | 5 | 4 |
| 15 | 38 | 10 | 8 | 7 |
| 20 | 51 | 14 | 12 | 9 |
| 25 | 62 | 21 | 14 | 11 |
| 30 | 69 | 30 | 17 | 13 |
| 35 | 74 | 40 | 20 | 15 |
| 40 | 78 | 52 | 23 | 18 |
| 45 | 81 | 63 | 27 | 21 |
| 50 | 84 | 72 | 33 | 24 |
| 55 | 86 | 78 | 42 | 27 |
| 60 | 88 | 83 | 55 | 30 |
| 65 | 90 | 87 | 69 | 34 |
| 70 | 92 | 90 | 79 | 40 |
| 75 | 94 | 92 | 86 | 47 |
| 80 | 95 | 94 | 91 | 57 |
| 85 | 96 | 96 | 94 | 74 |
| 90 | 97 | 97 | 96 | 88 |
| 95 | 98 | 98 | 98 | 95 |
| 100 | 100 | 100 | 100 | 100 |

From NOAA "Bulletin 71, Rainfall Frquency Atlas of the Midwest", 1992

## Median Time Distributions of Heavy Storm Rainfall on Areas of 50 to 400 Square Miles

Cumulative storm rainfall (percent) for given storm type




| Cumulative Storm Time (percent) | First quartile | Second quartile | Third quartile | Fourth quartile |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 5 | 8 | 2 | 2 | 2 |
| 10 | 17 | 4 | 4 | 3 |
| 15 | 34 | 8 | 7 | 5 |
| 20 | 50 | 12 | 10 | 7 |
| 25 | 63 | 21 | 12 | 9 |
| 30 | 71 | 31 | 14 | 10 |
| 35 | 76 | 42 | 16 | 12 |
| 40 | 80 | 53 | 19 | 14 |
| 45 | 83 | 64 | 22 | 16 |
| 50 | 86 | 73 | 29 | 19 |
| 55 | 88 | 80 | 39 | 21 |
| 60 | 90 | 86 | 54 | 25 |
| 65 | 92 | 89 | 68 | 29 |
| 70 | 93 | 92 | 79 | 35 |
| 75 | 95 | 94 | 87 | 43 |
| 80 | 96 | 96 | 92 | 54 |
| 85 | 97 | 97 | 95 | 75 |
| 90 | 98 | 98 | 97 | 92 |
| 95 | 99 | 99 | 99 | 97 |
| 100 | 100 | 100 | 100 | 100 |

From NOAA "Bulletin 71, Rainfall Frquency Atlas of the Midwest", 1992

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# APPENDIX E

# STRUCTURAL BEST MANAGEMENT PRACTICES:

# PONDS

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1. *Post-Construction Storm Water Management in New Development & Redevelopment: Dry Extended Detention Pond*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_9.cfm

2. *Post-Construction Storm Water Management in New Development & Redevelopment: Wet Ponds*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_26.cfm

3. *Storm Water Technology Fact Sheet: Wet Detention Ponds*
   http://www.epa.gov/owm/mtb/wetdtnpn.pdf

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# APPENDIX F

# STRUCTURAL BEST MANAGEMENT PRACTICES:

# INFILTRATION PRACTICES

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1. *Post-Construction Storm Water Management in New Development & Redevelopment: Infiltration Basin*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_13.cfm

2. *Storm Water Technology Fact Sheet: Infiltration Drainfields*
   http://www.epa.gov/owm/mtb/infltdrn.pdf

3. *Storm Water Technology Fact Sheet: Infiltration Trench*
   http://www.epa.gov/owm/mtb/infltrenc.pdf

4. *Post-Construction Storm Water Management in New Development & Redevelopment: Infiltration Trench*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_14.cfm

5. *Post-Construction Storm Water Management in New Development & Redevelopment: Porous Pavement*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_21.cfm

6. *Storm Water Technology Fact Sheet: Porous Pavement*
   http://www.epa.gov/owm/mtb/porouspa.pdf

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# APPENDIX G

# STRUCTURAL BEST MANAGEMENT PRACTICES:

# FILTRATION PRACTICES

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1. *Post-Construction Storm Water Management in New Development & Redevelopment: Bioretention*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_4.cfm

2. *Storm Water Technology Fact Sheet: Bioretention*
   http://www.epa.gov/owm/mtb/biortn.pdf

3. *Post-Construction Storm Water Management in New Development & Redevelopment: Sand and Organic Filters*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_23.cfm

4. *Storm Water Technology Fact Sheet: Sand Filters*
   http://www.epa.gov/owm/mtb/sandfltr.pdf

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# APPENDIX H

# STRUCTURAL BEST MANAGEMENT PRACTICES:

# VEGETATIVE PRACTICES

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1. *Post-Construction Storm Water Management in New Development & Redevelopment: Storm Water Wetland*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_27.cfm

2. *Storm Water Technology Fact Sheet: Storm Water Wetlands*
   http://www.epa.gov/owm/mtb/wetlands.pdf

3. *Post-Construction Storm Water Management in New Development & Redevelopment: Grassed Swales*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_24.cfm

4. *Storm Water Technology Fact Sheet: Vegetated Swales*
   http://www.epa.gov/owm/mtb/vegswale.pdf

5. *Post-Construction Storm Water Management in New Development & Redevelopment: Grassed Filter Strip*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_11.cfm

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# APPENDIX I

# STRUCTURAL BEST MANAGEMENT PRACTICES:

# RUNOFF PRETREATMENT PRACTICES

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1. *Post-Construction Storm Water Management in New Development & Redevelopment: Catch Basins/Catch Basin Insert*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_7.cfm

2. *Post-Construction Storm Water Management in New Development & Redevelopment: In-Line Storage*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_16.cfm

3. *Post-Construction Storm Water Management in New Development & Redevelopment: Manufactured Products for Storm Water Inlets*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_17.cfm

4. *Storm Water Technology Fact Sheet: Hydrodynamic Separators*
   http://www.epa.gov/owm/mtb/hydro.pdf

5. *Storm Water Technology Fact Sheet: Water Quality Inlets*
   http://www.epa.gov/owm/mtb/wtrqlty.pdf

6. *Storm Water Technology Fact Sheet: Modular Treatment Systems*
   http://www.epa.gov/owm/mtb/modtreat.pdf

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# APPENDIX J

# NON-STRUCTURAL BEST MANAGEMENT PRACTICES

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1. *Post-Construction Storm Water Management in New Development & Redevelopment: On-Lot Treatment*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_19.cfm

2. *Post-Construction Storm Water Management in New Development & Redevelopment: Buffer Zones*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_6.cfm

3. *Post-Construction Storm Water Management in New Development & Redevelopment: Open Space Design*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_20.cfm

4. *Post-Construction Storm Water Management in New Development & Redevelopment: Green Parking*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_12.cfm

5. *Post-Construction Storm Water Management in New Development & Redevelopment: Alternative Turnarounds*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_2.cfm

6. *Post-Construction Storm Water Management in New Development & Redevelopment: Alternative Pavers*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_1.cfm

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# APPENDIX K

# BEST MANAGEMENT PRACTICES INSPECTION AND MAINTENANCE

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1. *Post-Construction Storm Water Management in New Development & Redevelopment: BMP Inspection and Maintenance*
   http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_5.cfm

2. *Storm Water Technology Fact Sheet: Preventive Maintenance*
   http://www.epa.gov/owm/mtb/prevmain.pdf

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